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MODEL 6853
DIGITAL MULTIMETER
INSTRUCTION MANUAL

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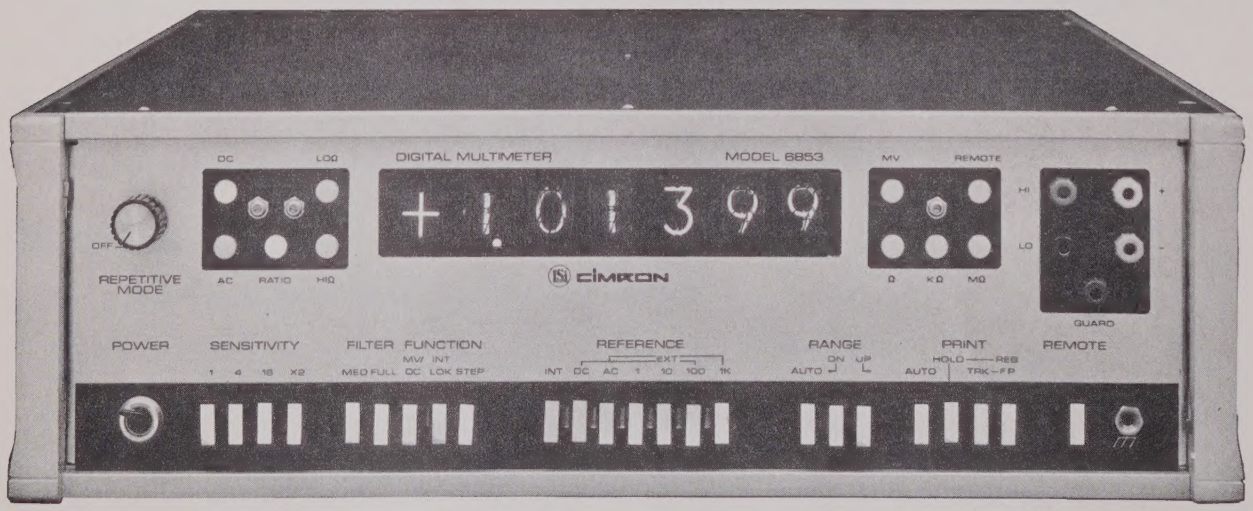
MODEL 6853
DIGITAL MULTIMETER
INSTRUCTION MANUAL



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MANUAL CHANGE

MANUAL AFFECTED: Model 6853 Digital Multimeter Instruction Manual

CHANGE NO. 2 **CHANGE DATE:** March 31, 1972

REASON FOR CHANGE: To incorporate engineering changes and correct technical errors.

The contents of Manual Change No. 1 have been included included in the Manual. It is recommended that the following changes be entered in the Manual:

Page 6-43/44

On schematic diagram: Change value of C4 to .1 and C5 to .2.

Page 6-133/134

On parts location and schematic diagrams: Change value of R41 to 4.7K.

Page 6-181/182

Schematic diagram relay K29: Change position of relay armature from lower contact closrure to upper contact closure.

Page 6-185/186

On schematic diagram: Delete the connecting line between Z10 pin 2 and Z12 pin 11.

Page 6-191/192

On parts location and schematic diagrams: Delete capacitor C17.

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SECTION I

INTRODUCTION

SCOPE

This instruction manual contains a description; specifications; operating instructions; calibration and specification verifying procedures; theory of operation; and maintenance information, parts lists, and diagrams applicable to the Cimron Model 6853 Digital Multimeter (DMM).

GENERAL DESCRIPTION

The basic Model 6853 DMM consists of a DC voltmeter and a DC/DC volt-ratiometer with signal and reference input cables, two rack mounting brackets and a bench stand. Optional accessories, available in any combination, are:

1. AC Converter Assembly (two required for AC/AC ratios)
2. HI Ohms–MV Converter Assembly.
3. Low Ohms Converter Assembly
4. 100 Megohm Range Assembly
5. Input Selector Assembly (required with any of items 1 through 4)
6. Print Control Assembly
7. A set of three Print Output Assemblies with one of the following types of print output logic:
   a. 1-2-4-8 BCD Voltage State, "1" = 0V, "0" = −12V or complement.
   b. 1-2-4-8 BCD Voltage State, "1" = 0V, "0" = +12V or complement
   c. 1-2-4-8 BCD Contact Closures
   d. 1-2-4-8 DTL Logic Levels, "0" = 0V, "1" = +5V
   e. 10-line Decimal Contact Closures
8. Remote Control Assembly, Non-Buffered DTL Logic Level type or Buffered Contact Closures type
9. 100-volt DC Ratio Reference Attenuator Subassembly
10. Printer or Punch Interface Cable
11. Rear Panel Signal and Reference Input Connectors with Mating Connectors
12. Johnathan 18" Rack Mounting Slide (pair)

With the exception of items 9 through 12, all optional accessories are of the plug-in type.

BASIC CAPABILITIES

The basic DMM employs the continuous balance, or tracking, principle of operation and can measure DC voltages and DC/DC voltage ratios. The DMM can:

1. Continuously sample an input signal and provide a front panel readout when a null is attained, or
2. Repetitively sample the input signal for 100 milliseconds and provide a readout at the completion of the sampling interval. Upon completion of a readout another 100 millisecond sampling cycle is started. When in the repetitive sample mode the input signal sampling rate can be varied from one to five times per second. The repetitive sample capability is particularly useful when noise on the signal makes it difficult to attain a null using the continuous sample mode. Switching to the repetitive sample mode forces the DMM to provide readouts from one to five times per second.

Measurement functions, sampling rates, sensitivity, and degree of input signal filtering can be selected manually with front panel controls.

The measurement range that provides maximum input signal resolution is automatically selected when the DMM is in Autorange. Ranges also can be manually selected with front panel controls.

The DMM has a front panel display of five digits (with a sixth digit for 10% overrange), an input signal polarity indicator, with polarity being detected automatically, and a decimal point indication. Front panel lights indicate the selected function.

Except for the 1-volt ratio range, when the DMM is in manual range and the input signal amplitude exceeds the upper range limits, a numeral 1 in the overrange (left) window blinks slowly and continually to indicate that the reading is erroneous. In the manual 1-volt ratio range the overrange indicator will display a 1 when the ratio is 0.1:1 or greater; if less than 0.1:1 the indication will be a 0.

DC VOLTAGE MEASUREMENT

The DMM can measure DC voltages from ±.00001 to ±1099.99 volts in four full-scale ranges of 1.09999, 10.9999, 109.999 and 1099.99.

DC/DC VOLTAGE RATIO MEASUREMENT

The DMM can measure +DC/+DC, +DC/-DC or -DC/+DC voltage ratios. Ratio is measured by comparing an unknown DC input voltage of either polarity to a known external DC reference voltage of either polarity. The external reference voltage can be any value from ±0.1 to ±10 volts. The ratio range is from .000001:1 to 1099.99:1 in five full-scale ranges of .109999:1, 1.09999:1, 10.9999:1, 109.999:1 and 1099.99:1. An optional (factory installation required) 100-volt DC Ratio Reference Attenuator Subassembly is available that permits the use of external reference voltages from ±10 to ±100 volts, with three full-scale ranges of .109999:1, 1.09999:1 and 10.9999:1.

CAPABILITIES WITH ACCESSORIES

The Model 6853 DMM equipped with any or all of the optional accessories has the basic capabilities. In addition, with appropriate accessories, the DMM can:

1. Measure:
   a. AC voltages
   b. Low-level DC voltages (microvolts)
   c. DC voltages that vary from microvolts-to-volts-to microvolts.
   d. Resistance
   e. AC/AC, AC/DC and DC/AC voltage ratios.
2. Automatically range through:
   a. Six ranges of DC millivolt through volt values
   b. Four ranges of AC voltage values
   c. Four ranges of AC voltage ratio values
   d. Four ranges of DC voltage ratio values
   e. Five ranges of low ohms (1 ohm to 10 kilohm) and six ranges of high ohms (1 kilohm to 100 megohms).
3. Provide a print output to drive a recording device.
4. Be remotely controlled. When remotely controlled:
   a. Sample the input signal from 0 to 60 times per second when in the repetitive sampling mode.
   b. Measure the ratio of DC millivolts to a positive external DC reference voltage.

Measurement functions, sampling rates, sensitivity, degree of input signal filtering, and print modes can be selected either manually or remotely. Ranging can be automatic or either manually or remotely controlled.

AC VOLTAGE MEASUREMENT

With a Model 5875 AC Converter Assembly installed, AC voltage measurements can be made over a frequency range of 50 Hz to 100 kHz. Within the limitations described in Section II, measurements of AC voltages from .00001 to 1000.00 volts can be made in four full-scale ranges of 1.09999, 10.0999, 109.999 and 1099.99.

DC MILLIVOLT MEASUREMENT

With a Model 5889 HI Ohms/MV Converter Assembly installed, measurements of DC voltages from ±0.0001 millivolts to ±109.999 millivolts can be made in two full-scale ranges of 10.9999 and 109.999.

DC MILLIVOLTS-TO-VOLTS-TO MILLIVOLTS MEASUREMENT

With a Model 5889 HI Ohms/MV Converter Assembly installed, measurements of DC voltages varying in value from ±0.0001 millivolts to ±1099.99 volts to ±0.0001 millivolts can be made.

The DMM will automatically uprange to the DC measurement mode when the input signal exceeds 109.999 millivolts and downrange to the millivolt mode when the signal decreases below 100.00 millivolts.

RESISTANCE MEASUREMENT

With a Model 5891 Low Ohms Converter Assembly installed, resistance measurements from .00001 ohm to 10.9999 kilohms can be made in five full-scale ranges of 1.09999, 10.9999 and 109.999 ohms, and 1.09999 and 10.9999 kilohms.

With a Model 5889 HI Ohms/MV Converter Assembly installed, resistance measurements from .00001 kilohm to 10.9999 megohms can be made in five full-scale ranges of 1.09999, 10.9999 and 109.999 kilohms and 1.0999 and 10.9999 megohms.

With a 100 Megohm Range Assembly installed resistance measurements from 10 to 109.999 megohms can be made.

The HI Ohms/MV Converter, the 100 Megohm Range Assembly and the Low Ohms Converter can be installed and operated together to provide a maximum range of resistance measurements. However, automatic ranging between low and high ohms is not possible.

Four-wire measurement technique is used in low ohm and kilohm ranges and two-wire is used in megohm ranges.

AC/AC RATIO MEASUREMENT

With two Model 5875 AC Converter Assemblies installed, one as the AC signal input converter and the other as the AC reference voltage converter, measurements of AC voltage ratios can be made from .000001:1 to 1099.99:1 in five full-scale ranges of .109999:1, 1.09999:1, 10.9999:1, 109.999:1, and 1099.99:1. The external AC reference voltage can be any value from 0.1 to 1000 volts.

AC/DC RATIO MEASUREMENT

With one Model 5875 AC Converter Assembly installed as the AC signal input converter, measurements of AC/DC voltage ratios can be made in the same ranges as in AC/AC ratio measurement. The external DC reference voltage can be any value from ±0.1 to ±10 volts. With an optional DC Ratio Reference Attenuator Subassembly installed, the DC reference voltage can be any value from ±10 to ±100 volts.

DC/AC RATIO MEASUREMENT

With one Model 5875 AC Converter Assembly installed as the AC reference voltage converter, measurements of DC/AC voltage ratios can be made in the same ranges as in AC/AC ratio measurement. The external AC reference voltage can be any value from 0.1 to 1000 volts.

PRINT OUTPUT

The print output provides an external recorder with five-digit numeral (six digits in overrange), range, polarity, and instrument function information. When remotely controlled, and DESENSE is programmed, desensitizing will be automatic when the input signal contains excessive noise. The degree of Desensitizing is included in the print output information

Print Output Assembly reference voltages are furnished by an isolated, internal DMM power supply.

REMOTE CONTROL

The DMM can be controlled from a remote control unit through an optional Remote DTL Assembly and rear panel connectors when isolation between the remote control unit and the DMM is not required. When isolation is required, control is through rear panel connectors and isolated contact closures mounted on an optional Remote Buffer Assembly. Remote Buffer Assembly relay coil voltages are furnished by an isolated, internal DMM power supply.

DC MILLIVOLT RATIO MEASUREMENT

When remotely controlled, ratio measurements can be made between DC millivolt input signals and an external DC reference voltage of from ±0.1 to ±10 volts. Location of the decimal in the front panel readout, however, must be controlled from the remote control unit.

FABRICATION

The DMM is 5.25 inches (133.4 mm) high, 17 inches (431.8 mm) wide, 18.5 inches (469.9 mm) deep and fits a standard rack. Low heat dissipation permits a completely enclosed cabinet, thereby reducing dust and humidity factors.

The signal input leads are floating and isolated from the case, power-line ground, and print output when print output is through isolated contact closures. A guard shield that may be externally driven is used to ensure maximum input isolation and common mode rejection. The input may be floated up to 1000 volts DC or peak AC in reference to power-line ground, provided the voltage between any pin on the input connector and the DMM does not exceed 1500 volts peak.

Virtually all components are mounted on plug-in, printed circuit boards, providing ease in troubleshooting and maintenance not usually found in complex electronic equipment. Solid-state components are used almost exclusively, including the digital potentiometer switches and converter chopper.

Manufacturing is in accordance with the best commercial practices for material, parts, and workmanship.

SECTION II
SPECIFICATIONS
GENERAL

POWER REQUIREMENTS:	105–125V/210-250V, 50-400 Hz, 80 watts maximum
OPERATING TEMPERATURE:	0°C to +50°C
COMMON MODE VOLTAGE:	1000 VDC guard to ground

NOTE

Accuracy specifications apply only when the instrument has been calibrated using equipment listed in Section IV calibration instructions.

DC VOLTAGE MEASUREMENT

RANGES, FULL SCALE (FS):	±1.09999V, ±10.9999V, ±109.999V, ±1099.99V
ACCURACY (90 DAYS):	
1V Range	±[0.01% FS + 0.005% Reading (RDG)]
10V, 100V, 1000V Ranges	±(0.001% FS + 0.005% RDG)
TEMPERATURE COEFFICIENT:	±(0.0002% FS + 0.0001% RDG)/°C
INPUT RESISTANCE:	
1V Range	1,000 MΩ minimum
10V Range	10,000 MΩ minimum
100V, 1000V Ranges	10 MΩ minimum
RESPONSE TIME:	To 0.002% of FS (Single range including polarity change)
	FILTER OUT: 40 ms
	FILTER MED: 260 ms
	FILTER FULL: 650 ms

COMMON MODE REJECTION:	With 100Ω unbalance in either input lead. Input may be floated to 1000 VDC or peak AC DC–10,000,000:1 (140 dB) AC (60 Hz) FILTER FULL–1,000,000:1 (120 dB)
NORMAL MODE REJECTION:	FILTER OUT: 0 dB FILTER MED: 40 dB at 60 Hz 75 dB at 400 Hz FILTER FULL: 90 dB at 60 Hz, increasing at 36 dB/octave

DC MILLIVOLTAGE MEASUREMENT

RANGES, FULL SCALE:	10.9999 mV, 109.999 mV
ACCURACY:	
10 mV Range	±(0.01% FS + 0.01% RDG)
100 mV Range	±(0.005% FS + 0.005% RDG)
GAIN STABILITY:	0.01% for at least 30 days
TEMPERATURE COEFFICIENT:	±(0.25 μV + 0.001% RDG)/°C (0.1 μV/°C typical after normal warmup)
INPUT RESISTANCE:	
10 mV Range	10 MΩ minimum
100 mV Range	100 MΩ minimum
SETTLING TIME:	To 0.01% of FS (Single range including polarity change)
10 mV Range	500 ms
100 mV Range	100 ms
COMMON MODE REJECTION:	With 100Ω unblanace in either input lead.
10 mV Range	DC: 150 dB 60 Hz: 140 dB
100 mV Range	DC: 140 dB 60 Hz: 130 dB

AC VOLTAGE MEASUREMENT

CAUTION

Between 50 Hz and 20 kHz, do not apply more than 1000V rms to the input signal connectors. Between 20 kHz and 50 kHz, do not apply more than 500V rms. Between 50 kHz and 100 kHz, do not apply more than 250V rms. Failure to observe this caution may result in damage to the instrument.

CONVERSION METHOD:	RMS equivalent of the average value of the input sine wave
RANGES, FULL SCALE:	1.09999V, 10.9999V, 109.999V, 1099.99V
FREQUENCY RANGE:	50 Hz – 100 kHz
ACCURACY:	
50 Hz – 20 kHz	±(0.02% FS + 0.08% RDG)
20 kHz – 50 kHz	±(0.05% FS + 0.15% RDG)
50 kHz – 100 kHz	±(0.05% FS + 0.4% RDG)
TEMPERATURE COEFFICIENT:	±(0.002% FS + 0.001% RDG)/°C
INPUT RESISTANCE:	1 MΩ all ranges
SETTLING TIME:	To 0.1% of FS (Single range)
FILTER OUT:	100 ms max., 1 kHz and higher
FILTER MED:	260 ms max., 100 Hz and higher
FILTER FULL:	650 ms max., 50 Hz and higher

HIGH OHMS MEASUREMENT

RANGES, FULL SCALE:	1.09999 kΩ, 10.9999 kΩ, 109.999 kΩ 1.09999 MΩ, 10.9999 MΩ, 109.999 MΩ
ACCURACY:	
1 kΩ, 10 kΩ, 100 kΩ Ranges	±(0.005% FS + 0.01% RDG)
1 MΩ Range	±(0.005% FS + 0.03% RDG)
10 MΩ Range	±(0.005% FS + 0.05% RDG)
100 MΩ Range	±(0.05% FS + 0.15% RDG)

TEMPERATURE COEFFICIENT:

1 kΩ through 1 MΩ Ranges	±(0.0005% FS + 0.001% RDG)/°C
10 MΩ Range	±(0.001% FS + 0.005% RDG)/°C
100 MΩ Range	±(0.005% FS + 0.04% RDG)/°C

MAXIMUM VOLTAGE ACROSS UNKNOWN RESISTOR: 20 VDC (out of range)

SETTLING TIME: To 0.01% of FS (single range)

1 kΩ, 10 kΩ, 100 kΩ Ranges	100 ms
1 MΩ Range	250 ms
10 MΩ Range	1 sec

LOW OHMS MEASUREMENT

RANGES, FULL SCALE: 1.09999Ω, 10.9999Ω, 109.999Ω, 1.09999 kΩ, 10.9999 kΩ

ACCURACY:

1Ω Range	±0.01% FS or ±0.03% RDG, whichever is greater
10Ω, 100Ω Ranges	±0.005% FS or ±0.02% RDG, whichever is greater
1 kΩ, 10 kΩ Ranges	±0.005% FS or ±0.02% RDG, whichever is greater

TEMPERATURE COEFFICIENT:

1Ω Range	±(0.0025% FS + 0.002% RDG)/°C
10Ω, 100Ω, 1 kΩ, 10 kΩ Ranges	±(0.001% FS + 0.002% RDG)/°C

CURRENT THROUGH UNKNOWN RESISTOR:

1Ω, 10Ω Ranges	10 mA
100Ω Range	1 mA
1 kΩ Range	100 μA
10 kΩ Range	10 μA

SETTLING TIME: To 0.01% FS (Single Range)

FILTER MED:	500 ms
FILTER FULL	700 ms

DC/DC RATIO

RANGES, FULL SCALE:

1V Reference	1.09999:1, 10.9999:1, 109.999:1, 1099.99:1

RANGES, FULL SCALE (CONT.):

10V Reference	.109999:1, 1.09999:1, 10.9999:1, 109.999:1
100V Reference	.109999:1, 1.09999:1, 10.9999:1

ACCURACY:

1V Reference	$\pm(0.01 \frac{1}{E_{Ref}}$ % FS + 0.005% RDG)
10V Reference	$\pm(0.001 \frac{10}{E_{Ref}}$ % FS + 0.005% RDG)
100V Reference	$\pm(0.003 \frac{100}{E_{Ref}}$ % FS + 0.002% RDG)
RESOLUTION:	1 digit or $\frac{10}{E_{Ref}}$, whichever is greater

INPUT RESISTANCE:

1V, 10V References	1,000 MΩ
100V Reference	10 MΩ

AC/AC RATIO

RANGES, FULL SCALE:

1V Reference	1.09999:1, 10.9999:1, 109.999:1, 1099.99:1
10V Reference	.109999:1, 1.09999:1, 10.9999:1, 109.999:1
100V Reference	.109999:1, 1.09999:1, 109.999:1
1000V Reference	.109999:1, 1.09999:1

ACCURACY: Signal and reference voltages same frequency and FS range

50 Hz – 20 kHz	±0.06% RDG or $\pm 0.02\% \text{ FS} \frac{\text{REF FS}}{E_{Ref}}$, whichever is greater
20 kHz – 50 kHz	$\pm 0.1\% \text{ RDG or } \pm 0.05\% \text{ FS} \frac{\text{REF FS}}{E_{Ref}}$, whichever is greater
50 kHz – 100 kHz	$\pm[(0.05\% \text{ FS} + 0.08\% \text{ RDG}) \frac{\text{REF FS}}{E_{Ref}}]$

AC/DC RATIO

RANGES, FULL SCALE:

1V Reference	1.09999:1, 10.9999:1, 109.999:1, 1099.99:1

RANGES, FULL SCALE (CONT.):

10V Reference	.109999:1, 1.09999:1, 10.9999:1, 109.999:1
100V Reference	.109999:1, 1.09999:1, 10.9999:1

ACCURACY:

AC Signal Converter accuracy specifications $\pm(0.001\%\ \text{FS}\ \frac{\text{REF FS}}{E_{Ref}})$

DC/AC RATIO

RANGES, FULL SCALE:

1V Reference	1.09999:1, 10.9999:1, 109.999:1, 1099.99:1
10V Reference	.109999:1, 1.09999:1, 10.9999:1, 109.999:1
100V Reference	.109999:1, 1.09999:1, 10.9999:1
1000V Reference	.109999:1, 1.09999:1

ACCURACY:

50 Hz – 10 kHz	$\pm[(0.01\%\ \text{FS} + \text{AC Signal Converter accuracy specification})\ \frac{\text{REF FS}}{E_{Ref}}]$
10 kHz – 50 kHz	$\pm[(0.03\%\ \text{FS} + \text{AC Signal Converter accuracy specification})\ \frac{\text{REF FS}}{E_{Ref}}]$
50 kHz – 100 kHz	$\pm[(0.05\%\ \text{FS} + \text{AC Signal Converter accuracy specification})\ \frac{\text{REF FS}}{E_{Ref}}]$

SECTION III
OPERATING INSTRUCTIONS

INSPECTION

The Model 6853 Digital Multimeter (DMM) is tested under severe environmental conditions prior to shipment. It is ready for immediate use upon receipt. Make the following checks, however, to ensure that the equipment has not been damaged in shipment:

1. Inspect the shipping container prior to acceptance from the carrier. If damage to the container is evident, remove the instrument from the container and visually inspect for damage to instrument parts. Note any damage to the instrument and container on the carrier's receipt for the carrier's agent to sign. A claim for damage, with a copy to Cimron Division, Lear Siegler, Inc. must be filed with the carrier within 15 days following receipt of the instrument.

2. If damage is not apparent until after the instrument is accepted, a claim for concealed damage, with a copy to Cimron, must be filed with the carrier within 15 days following receipt of the instrument.

3. When a claim is filed against the carrier, all packaging material should be retained for inspection.

4. If the instrument is damaged in shipment, failure to file a claim against the carrier within the specified time, with a copy to Cimron, may nullify the warranty in the event damage is reported to Cimron at a later date.

OPERATING CONTROLS, INDICATORS, AND CONNECTORS

Instrument operating controls, indicators, and connectors are located on the front and rear panels, as shown in figure 3-1.

Table 3-1 lists the operating controls, indicators and connectors and describes the function of each. Schematic reference designations are shown on the Master Schematic diagram.

OPERATIONAL CHECKOUT

NOTE

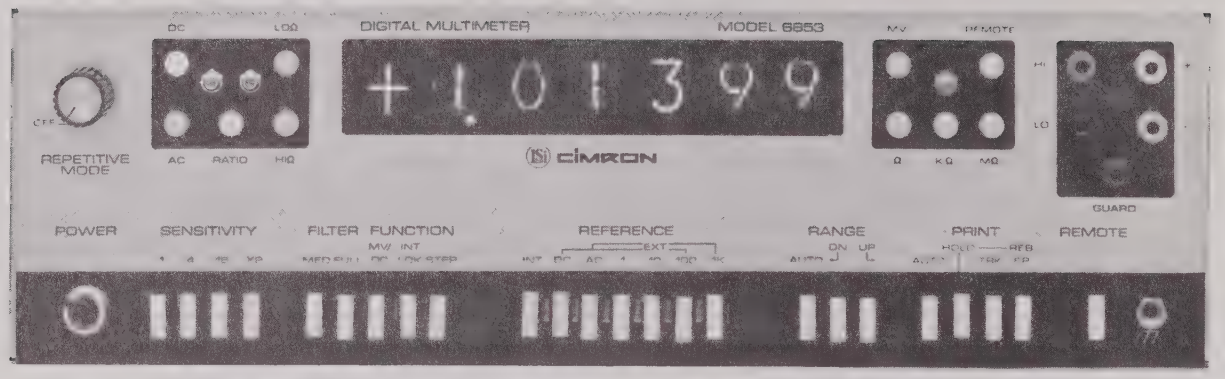
The liability of Cimron under the warranty is negated if the instrument is improperly repaired. If trouble is experienced during the operational checkout, refer to the warranty for instructions before attempting repair.

The operational checkout is intended as a preliminary test of operation and not to verify performance specifications. The checkout procedure assumes that all optional equipment is included in the instrument. Omit test equipment and procedural steps that apply to optional capabilities not included in the instrument.

The following test equipment is required to perform the operational checkout:

1. DC voltage source, 10 mV to 1000V.

2. DC voltage source 1V to 100V.



A. Front Panel

B. Rear Panel

Figure 3-1. Model 6853 Operating Controls, Indicators, and Connectors.

Table 3-1. Operating Controls, Indicators, and Connectors.

CONTROL, INDICATOR OR CONNECTOR	POSITION OR CONDITION	FUNCTION
FRONT PANEL		
REPETITIVE MODE (Switch/Potentiometer S1)	ON	Enables repetitive sampling of input signal.
	Rotated Clockwise	Increases repetitive sampling rate from 1 to 5 times per second.
DC (Indicator DS2)	Lighted	Indicates DC voltage measurement mode.
Screwdriver Adjustment (R4)	Variable	Enables adjustment of front panel numeral readout to .00000 when in 1V DC range with red and black input leads connected together.
Screwdriver Adjustment (R3)	Variable	Enables adjustment of LOΩ amplifier current.
		NOTE When the LOΩ, AC, or HIΩ function has been selected and the LOΩ, AC, or HIΩ indicator continually blinks, the associated converter is not installed in the DMM.
LOΩ (Indicator DS5)	Lighted	Indicates Low Ohms Converter installed and 4-wire ohm measurement mode.
AC (Indicator DS3)	Lighted	Indicates AC voltage measurement mode.
RATIO (Indicator DS1)	Lighted	Indicates ratio measurement mode.
HIΩ (Indicator DS4)	Lighted	Indicates HIΩ-MV Converter installed and 4-wire ohm measurement mode on 1kΩ, 10kΩ, or 100kΩ ranges and 2-wire measurement mode on 1MΩ, 10MΩ, or 100MΩ ranges.

Table 3-1. Operating Controls, Indicators, and Connectors (Cont.)

CONTROL, INDICATOR, OR CONNECTOR	POSITION OR CONDITION	FUNCTION
AC and RATIO Indicators	Lighted	Indicates DMM measuring the ratio of an AC input signal to either a DC or AC external reference voltage.
DC and RATIO Indicators	Lighted	Indicates DMM measuring the ratio of a DC input signal to either a DC or AC external reference voltage. **NOTE** In DC/DC ratio measurements the readout polarity sign is determined by the algebraic sum of the signal and external reference voltages.
+ (Indicator A2DS1)	Lighted	Indicates + polarity input signal in DC voltage measurement.
– (Indicator A2DS1)	Lighted	Indicates – polarity input signal in DC voltage measurement.
Decimal Indicators	Lighted	Indicates DMM in:
D0 (A2DS2)	.XXXXXX	0.1:1 ratio range
D1 (A2DS2)	.XXXXX	1:1 ratio, 1V DC or AC, or 1Ω, 1kΩ, or 1MΩ range.
D2 (A2DS3)	X.XXXX	10:1 ratio, 10 mV, 10V DC or AC, or 10Ω, 10kΩ, or 10MΩ range.
D3 (A2DS4)	XX.XXX	100:1 ratio, 100 mV, 100V DC or AC, or 100Ω, 100kΩ, or 100MΩ range.
D4 (A2DS5)	XXX.XX	1000:1 ratio, 1000V DC or AC range.
Numeral Indicators (A2DS2 thru A2DS7)	XXXXXX	Indicates value of input signal, state of each Decade, and print output configuration. The most significant digit window: 1. When instrument is in any range other than 0.1:1 Ratio range, will display a 1 to indicate instrument is in a 10% overrange condition. At other times window is blank.

Table 3-1. Operating Controls, Indicators, and Connectors (Cont.)

CONTROL, INDICATOR, OR CONNECTOR	POSITION OR CONDITION	FUNCTION
Numeral Indicators (Cont.)		2. In 0.1:1 Ratio range, will display a 1 when the ratio is 0.1:1 or greater. If ratio is less than 0.1:1 will display a zero. 3. In Manual Range or when in Auto-range with medium or full filter: a. Except in 0.1:1 Ratio range, when input signal amplitude exceeds upper range limits, displays a slowly blinking 1. b. In 0.1:1 Ratio range, when input signal exceeds upper range limits, alternately displays a 1 and zero.
MV (Indicator DS6)	Lighted	Indicates DC measurement mode in the 10 or 100 millivolt range.
Screwdriver Adjustment (R2)	Variable	Enables adjustment of front panel numeral readout to 0.0000 when in 10 mV range with red and black input leads connected together.
REMOTE (Indicator DS10)	Lighted	Indicates DMM in remote control configuration.
Ω (Indicator DS7)	Lighted	Indicates ohms measurement in the 1, 10, or 100 ohms range.
KΩ (Indicator DS8)	Lighted	Indicates kilohms measurement in the 1k, 10k or 100k ohms range.
MΩ (Indicator DS9)	Lighted	Indicates megohms measurement in the 1M, 10M, or 100M ohms range.
HI (Connector E1) and LO (Connector E2) (Both connectors are in parallel with rear panel connector J5 if J5 is installed.)		Connects input signals, via 100 Megohm Range Assembly, to Input Selector Assembly, if installed; otherwise via a jumper to the Input Amplifier Assembly.

Table 3-1. Operating Controls, Indicators, and Connectors (Cont.)

CONTROL, INDICATOR, OR CONNECTOR	POSITION OR CONDITION	FUNCTION
GUARD (Connector E3)		When connected to input signal source, terminates instrument guard shield at signal source.
+ (Connector E4) and – (Connector E5) (Both connectors are in parallel with rear panel connector J6 if J6 is installed.)		1. Connects external reference voltage to Input Selector Assembly, if installed; otherwise via a jumper to the Reference Amplifier Assembly. 2. In 4-wire ohms measurement mode connects internally generated current to external resistance under measurement.
POWER (Toggle Switch S5)	Up	Connects primary AC power to DMM power supply.
SENSITIVITY (Pushbutton Switch S2A)		
1	Depressed	Sets sensitivity to 100 μV per digit.
4	Depressed	Sets sensitivity to 400 μV per digit.
16	Depressed	Sets sensitivity to 1600 μV per digit.
X2	Depressed	Decreases selected sensitivity by a factor of 2.
FILTER (Pushbutton Switch S2B)		
MED	Depressed	Provides medium filtering of input signal.
FULL	Depressed	Provides maximum filtering of input signal. When neither MED or FULL is depressed no filtering is provided.

Table 3-1. Operating Controls, Indicators, and Connectors (Cont.)

CONTROL, INDICATOR, OR CONNECTOR	POSITION OR CONDITION	FUNCTION
FUNCTION (Push-button Switch S2C)		
MV/DC	Depressed	Enables measurement of voltages from a DC millivolt source in 10 and 100 millivolt ranges.
INT LOK	Depressed	Closes HI input signal circuit.
STEP (Momentary Contact)	Depressed	Opens HI input signal circuit. Is successively depressed until desired function is attained, as indicated by appropriate Function indicator being lighted.
REFERENCE (Pushbutton Switch S3)		
INT	Depressed	Disables all REFERENCE EXT switches. Selects internal reference voltage.
EXT DC	Depressed	Disables INT and EXT AC switches. Causes external DC reference voltage to be routed to Reference Amplifier Assembly.
EXT AC	Depressed	Disables INT and EXT DC switches. Causes external AC reference voltage to be routed to reference AC Converter Assembly.
1,10,100,1K	Depressed	1. When the external reference voltage is DC and: a. the reference voltage is between 0.1 and 1V, the 1 switch sets the Reference Amplifier to the 1V range.

Table 3-1. Operating Controls, Indicators, and Connectors (Cont.)

CONTROL, INDICATOR OR CONNECTORS	POSITION OR CONDITION	FUNCTION
REFERENCE (Cont.) 1,10,100,1K		b. The reference voltage is between 1 and 10V, the 10 switch sets the Reference Amplifier to the 10V range. c. The reference voltage is between 10 and 100V, the 100 switch sets the Comparator to the 100V range. 2. When external reference voltage is AC, sets the reference AC Converter Assembly to the 1, 10, 100, or 1K ranges.
RANGE (Pushbutton Switch S4A)		
AUTO	Depressed	Enables DMM, except reference AC Converter and 10-100V DC Reference Attenuator, to automatically range in all functions. Disables RANGE DN and UP switches. In AUTO RANGE DMM will range from 10 mV to 1000 VDC, providing first voltage step while in the mV range does not exceed 200V.
DN (Momentary Contact)	Depressed	Enables manual down ranging. The DMM steps to next lower range each time switch is depressed. Disables RANGE AUTO switch.
UP (Momentary Contact)	Depressed	Enables manual up ranging. The DMM steps to next higher range each time switch is depressed. Disables RANGE AUTO switch.
PRINT (Pushbutton Switch S4B)		
AUTO	Depressed	1. In repetitive sampling mode, enables instrument to track input signal during each sampling period and issue a printout at end of sampling period.

Table 3-1. Operating Controls, Indicators, and Connectors (Cont.)

CONTROL, INDICATOR, OR CONNECTOR	POSITION OR CONDITION	FUNCTION
PRINT (Cont.)		
AUTO		2. In continuous sampling mode enables instrument to continuously track input signal and issue a printout at end of each null.
HOLD	Depressed	In both repetitive and continuous sampling modes, disables instrument tracking and print output circuitry and enables REB switch.
TRK	Depressed	1. In repetitive sampling mode, enables instrument to track signal, null, and provide a readout during sampling period and then hold until another sample command is generated. Print output circuitry is disabled. 2. In continuous sampling mode, enables instrument to continuously track, null, and provide a readout. Print output circuitry is disabled.
REB–FP (Momentary Contact)	Depressed	1. When in HOLD and continuous sampling mode (in repetitive sampling mode switch has no effect) enables a single sample, null, readout, and printout sequence. Instrument then returns to HOLD. 2. When in PRINT TRK mode, and either continuous or repetitive sampling mode, causes instrument to issue a single printout of the front panel readout.
REMOTE (Push On–Push Off Switch S7)	Push On	Enables remote control of instrument sensitivity, filtering, ranging, functions, sampling modes and print modes. Remote control is enabled regardless of other switch positions.
(Lug and Banana Jack E6)		Enables connection of external source to DMM powerline ground.

Table 3-1. Operating Controls, Indicators, and Connectors (Cont.)

CONTROL, INDICATOR, OR CONNECTOR	POSITION OR CONDITION	FUNCTION
REAR PANEL		
J5 Signal (Connector)		In parallel with and performs same functions as front panel HI and LO connectors.
115–230 (Slide Switch S6)	115	Enables operation of DMM on 105-125 VAC power.
	230	Enables operation of DMM on 210-250 VAC power.
F1 (Fuse) 1 Amp Slo-Blo		Overload protective device in series with external AC power source.
J1 (Connector)		Connects Remote Assembly to remote control unit.
J2 (Connector)		Connects Print Output No. 1 Assembly to an external recorder.
J3 (Connector)		Connects Print Output No. 2 Assembly to an external recorder and to remote control unit.
J4 (Connector)		Connects Print Output No. 3 Assembly to an external recorder.
J6 (Connector)		In parallel with and performs same function as front panel + and – connectors.

3. AC voltage source, 1V to 1000V variable output and any frequency between 50 Hz and 10 kHz, if AC measurement option included. Two AC voltage sources are required if AC/AC ratio option included.

4. Decade resistance box, 1 ohm to 100 megohms, if resistance measurement option included.

5. Recording device suitable for operation with the type of print output assemblies installed in the machine.

6. Two 50-pin connectors, Amphenol No. 57-10500, if remote option included.

PRELIMINARY PROCEDURE

NOTE

In the guarded Signal Input Cable the red and black leads are the high and low signal input leads respectively. The green lead is used to terminate the instrument guard shield at the signal source. Whenever applicable, the green lead should be connected to the center of the source impedance. At all other times the green lead should be connected to the black lead. The Reference Cable yellow and blue leads are the external reference voltage input leads when the DMM is in a ratio measurement mode. In the 4-wire ohms measurement mode the yellow and blue leads are the current path for the internally generated current that is applied to the external resistance.

1. Connect the Signal Input Cable red, black, and green and the Reference Cable yellow and blue leads to the corresponding colored front panel connectors. Connect the free ends of the green and black leads together. Connect the free ends of the red and black leads together.

2. Position the rear panel line voltage switch to 115 or 230, dependent upon the AC line power available.

3. Insert the DMM power plug into a 3-wire, 105-125V or 210-250V, 50-400Hz power outlet.

4. Position the DMM front panel switches as indicated in table 3-2. Pushbutton switches, except momentary contact switches, should be depressed until they latch in the depressed position. When the REMOTE CONTROL switch is depressed-to-on, it is latched in the depressed position. When depressed-to-off it is in a not-depressed position. To expedite the checkout procedure, changes in DMM and test equipment switch positions should be made only as directed in the checkout procedural steps.

Table 3-2. Initial Positions of DMM Front Panel Switches.

SWITCH	POSITION
REPETITIVE MODE	OFF
SENSITIVITY 1	Depressed
SENSITIVITY X2	Unlatched
FILTER	Unlatched
FUNCTION MV/DC	Unlatched
FUNCTION INT LOK	Depressed
REFERENCE INT	Depressed
RANGE AUTO	Depressed
PRINT TRACK	Depressed
REMOTE CONTROL	Unlatched
POWER	ON (Up)

CHECKOUT PROCEDURE

When the DMM has warmed up perform the checkout procedure as follows:

NOTE

When power is first applied to the DMM and front panel switches are positioned as indicated in table 3-2, the instrument is automatically placed in the DC function and the 1-volt range. The DC function indicator will light.

1. DC Voltage Measurement.

   a. If the front panel numerical readout is not .00000 vary the screwdriver adjustment located

between and above the front panel AC and RATIO function indicators to zero the readout.

b. Connect the DMM red and black leads to the 10 mV to 1000 VDC voltage source with the red lead to the positive terminal.

c. Adjust the voltage source output first to 1.00000V and then 1000.00V. Observe a DMM readout of +1.00000 and then +1000.00.

d. Depress the RANGE UP switch.

e. Apply 10.0000V to the DMM. Depress the RANGE DN switch twice. Observe a readout of +10.0000.

f. Depress the RANGE DN switch once. Observe that the readout overrange window displays a blinking 1.

g. Adjust the voltage source output to zero.

h. Depress the RANGE AUTO switch.

2. DC Millivolts Measurement.

a. Connect the signal input leads together. Depress the FUNCTION MV/DC switch.

b. Observe that the DC and MV function indicators are lighted.

c. If the front panel numerical readout is not 0.0000 vary the screwdriver adjustment located above the front panel KΩ function indicator to zero the readout.

CAUTION

Do not apply more than 125V to the red and black leads when the DMM is in the millivolt mode and not in auto-range. Failure to observe this caution will open the fuse in the millivolt section of the HIΩ-MV Converter assembly.

d. Connect the DMM red and black leads to the 10 mV to 1000V DC voltage source with the black lead to the voltage source positive terminal.

e. Adjust the voltage source output first to 10.0000 mV and then 100.000 mV. Observe a DMM readout of −10.0000 and then −100.000.

3. Millivolts-to-Volts-to-Millivolts Measurement.

CAUTION

Do not apply more than 200 volts in one step to the red and black leads when the DMM is in the millivolt mode and in auto range. Failure to observe this caution will open the fuse in the millivolt section of the HIΩ-MV Converter assembly.

a. Adjust the DC voltage source output to 95 mV. Slowly increase the output to 120 mV. Observe that when the DMM readout exceeds 109.999 the mV function indicator extinguishes.

b. Slowly decrease the DC voltage source output to 95 mV. Observe that when the DMM readout decreases below .10000 the MV function indicator is lighted.

c. Slowly increase the DC voltage source output until the MV function indicator is extinguished.

d. Unlatch the MV/DC switch.

4. DC/DC Ratio Measurement

a. Connect the DMM yellow and blue reference leads to the 1-to-100 VDC voltage source (reference) with the yellow lead to the positive terminal.

NOTE

If the optional DC Reference Voltage Attenuator is installed, do not perform steps b through i. Perform steps j through p.

CAUTION

Do not exceed 10 VDC reference input. Failure to observe this caution may damage the Reference Amplifier Assembly.

b. Adjust the reference DC voltage source output to 10.0000V. Depress the REFERENCE EXT DC and REFERENCE EXT 10 switches. Observe that the DC and RATIO function indicators are lighted.

c. Adjust the signal DC voltage source first to 1.00000V and then to 1000.00V. Observe the DMM readout is first +.100000 and then +100.000.

d. Adjust the signal DC voltage source to10.0000V. Observe the readout is +1.00000.

e. Interchange the DMM red and black lead connections to the signal source. Observe the readout is −1.00000.

f. Interchange the DMM yellow and blue lead connections to the reference source. Observe the readout is +1.00000.

g. Interchange the DMM red and black lead connections to the signal source. Observe the readout is −1.00000.

h. Depress RANGE DN switch once. Observe the DMM overrange window alternately displays a 1 and a 0.

i. Depress the RANGE UP switch once. Adjust the reference voltage source to 1.00000V. Depress the REFERENCE EXT 1 switch. Observe the readout is −10.0000.

CAUTION

Do not exceed 100 VDC reference input. Failure to observe this caution may damage the Reference Amplifier Assembly.

j. Adjust the reference DC voltage source to 100V. Depress the REFERENCE EXT DC and REFERENCE EXT 100 switches.

k. Adjust the signal DC voltage source first to 10.0000V and then to 1000.00V. Observe the DMM readout is first +.100000 and then +10.0000.

l. Adjust the signal DC voltage source to 100.000V. Observe the readout is +1.00000.

WARNING

In the following steps, prior to interchanging leads adjust the voltage source output to zero. Adjust the source output to 100.000V after the leads have been interchanged. Failure to observe this warning may cause injury or death to personnel.

m. Interchange the DMM red and black lead connections to the signal source. Observe the readout is −1.00000.

n. Interchange the DMM yellow and blue lead connections to the reference source. Observe the readout is +1.00000.

o. Interchange the DMM red and black lead connections to the signal source. Observe the readout is −1.00000.

p. Depress the RANGE DN switch once. Observe the DMM overrange window alternately displays a 1 and a 0.

q. Adjust the two signal source outputs to zero and disconnect from the DMM. Depress the REFERENCE INT and RANGE AUTO switches. Connect the DMM red and black leads together.

5. Ohms Measurement

CAUTION

Do not apply voltage to the DMM red and black leads when the DMM is in the Ohms Measurement Mode. Failure to observe this caution may open the fuses in the ohms section of the HIΩ-MV Converter Assembly or damage the Low Ohm Converter Assembly.

a. LOΩ Mode

(1) Depress the FUNCTION STEP switch repeatedly until the LOΩ and Ω function indicators are lighted.

(2) If the front panel readout is not 0.0000 vary the screwdriver adjustment located above the front panel KΩ function indicator to zero the readout.

(3) Connect the DMM signal and reference leads to the decade resistance box terminals exactly as shown in figure 3-2. Except for the green lead to black lead connection, do not stack the leads by plugging one lead connector into another lead connector.

(4) Push the FUNCTION INTER LOK switch.

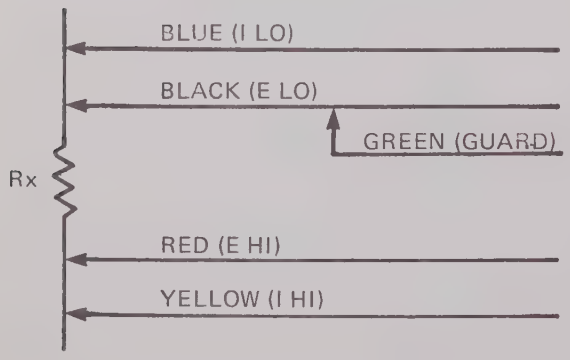


Figure 3-2. Four-Wire Ohms Measurement Test Setup.

(5) Adjust the resistance box to first 1Ω and then 100Ω. Observe a readout of 1.00000 and then 100.000.

(6) Depress the RANGE UP switch once. Observe that the KΩ function indicator is lighted, the Ω indicator is extinguished, and the LOΩ indicator remains lighted.

(7) Adjust the resistance box to 1 kΩ. Observe a readout of 1.00000.

(8) Depress the RANGE UP switch once. Adjust the resistance box to 10 kΩ. Observe a readout of 10.0000.

b. HIΩ Mode

(1) Depress the RANGE AUTO switch. Depress the FUNCTION STEP switch repeatedly until the HIΩ and KΩ function indicators are lighted.

(2) Depress the FUNCTION INT LOK switch.

NOTE

When measuring resistance in the 100 kΩ and higher ranges ensure that the resistance box is grounded and that the leads between the box and the DMM input leads are kept as short as possible. This precaution reduces the effect of hum pickup which could cause offset or rattling.

(3) Adjust the resistance box to first 1 kΩ and then 100 kΩ. Observe a readout of 1.00000 and then 100.000.

(4) Depress the RANGE UP switch once. Observe that the MΩ function indicator is lighted, the KΩ indicator is extinguished, and the HIΩ indicator remains lighted.

NOTE

When measuring resistance greater than 100 kΩ the DMM automatically changes to 2-wire measurement.

(5) Adjust the resistance box to 1 MΩ. Observe a readout of 1.00000.

(6) Depress the RANGE UP switch twice. Adjust the resistance box to 100 MΩ. Observe a readout of 100.000.

(7) Disconnect the resistance box from the DMM.

6. AC Voltage Measurement

CAUTION

Between 50 Hz and 20 kHz, do not apply more than 1000V rms to the input signal connectors. Between 20 kHz and 50 kHz, do not apply more than 500V rms. Between 50 kHz and 100 kHz, do not apply more than 250V rms. Failure to observe this caution may result in damage to the instrument.

a. Depress the RANGE AUTO switch. Depress the FUNCTION STEP switch repeatedly until the AC function indicator is lighted.

b. Depress the FUNCTION INT LOK switch.

c. Connect the DMM red and black leads to the AC voltage source.

d. Adjust the voltage source frequency to 1 kHz and output voltage first to 1.00000V and then 1000.00V. Observe a DMM readout of 1.00000 and then 1000.00.

e. Reduce the voltage source output to zero.

7. AC/AC Ratio Measurement

CAUTION

Between 50 Hz and 20 kHz do not apply more than 1000V rms to the input signal connectors or reference voltage connectors. Between 20 kHz and 50 kHz do not apply more than 500V rms. Between 50 kHz and 100 kHz do not apply more than 250V rms. Failure to observe this caution may result in damage to the instrument.

a. Connect the second AC voltage source (reference) to the yellow and blue reference cable leads. Adjust the reference source frequency to 1 kHz and output voltage to 10.0000V.

b. Depress the REFERENCE EXT AC and REFERENCE EXT 10 switches. Observe the AC and RATIO function indicators are lighted.

c. Adjust the signal AC voltage source frequency to 1 kHz and output voltage first to 1.00000 and then to 1000.00. Observe the readout is .100000 and then 100.000.

d. Adjust the signal AC voltage source to 100.000V. Adjust the reference AC voltage source to 1.00000V. Depress the REFERENCE EXT 1 switch. Observe the readout is 100.000.

e. Depress the REFERENCE EXT 100 switch. Adjust the reference AC voltage source to 100.000V. Observe the readout is 1.00000.

f. Depress the REFERENCE EXT 1K switch. Adjust the reference AC voltage source to 1000.00V. Observe the readout is .100000.

g. Reduce the signal source output to zero and disconnect it from the DMM. Reduce reference voltage to 10.0000V. Depress the REFERENCE EXT 10 switch.

8. DC/AC Ratio Measurement

a. Connect the DMM red and black leads together. Depress the FUNCTION STEP switch repeatedly until the DC function indicator is lighted. The RATIO indicator remains lighted.

b. Depress the FUNCTION INT LOK switch.

c. If the front panel numerical readout is not .00000 vary the screwdriver adjustment located between and above the AC and RATIO function indicators to zero the readout.

d. Connect the DMM red and black leads to the DC voltage source (signal) with the black lead to the positive terminal.

e. Adjust the signal source output to 1.00000V. Observe that the DMM readout is −.100000.

f. Interchange the DMM red and black lead connections to the signal source. Observe a DMM readout of +.100000.

g. Adjust the signal source output to 1000.00V. Observe a DMM readout of +100.000.

h. Adjust the signal and reference voltage source outputs to zero and disconnect them from the DMM.

9. AC/DC Ratio Measurement

a. Connect the DMM yellow and blue leads to the reference DC voltage source with the yellow lead to the reference source positive terminal.

NOTE

If the optional DC Reference Voltage Attenuator is installed, do not perform steps b through f. Perform steps g through m.

CAUTION

Do not exceed 10 VDC reference input. Failure to observe this caution may damage the Reference Amplifier Assembly.

b. Adjust the reference voltage source output to 10.0000V. Depress the REFERENCE EXT DC and REFERENCE EXT 10 switches.

c. Depress the FUNCTION STEP switch once and observe the AC function indicator is lighted. The RATIO indicator remains lighted. Depress the FUNCTION INT LOK switch.

d. Connect the DMM red and black leads to the signal AC voltage source. Adjust the signal source frequency to 1 kHz and output voltage to 1.00000V. Observe a DMM readout of .100000.

e. Interchange the yellow and blue lead connections to the reference voltage source. Observe a DMM readout of .100000.

f. Adjust the signal source output to 1000.00V. Observe a DMM readout of 100.000.

CAUTION

Do not exceed 100 VDC reference input. Failure to observe this caution may damage the Reference Amplifier Assembly.

g. Adjust the reference voltage source output to 10.0000V. Depress the REFERENCE EXT DC and the REFERENCE EXT 10 switches.

h. Adjust the reference voltage source output to 100.000V. Depress the REFERENCE EXT 100 switch.

i. Depress the FUNCTION STEP switch once and observe the AC function indicator is lighted. The RATIO indicator remains lighted. Depress the FUNCTION INT LOK switch.

j. Connect the DMM red and black leads to the signal AC voltage source. Adjust the signal source frequency to 1 kHz and output voltage to 10.0000V. Observe a DMM readout of .100000.

k. Reduce the reference voltage source output to zero. Interchange the yellow and blue lead connections to the reference voltage source.

l. Adjust the reference voltage source output to 100.000V. Observe a DMM readout of .100000.

m. Adjust the signal source output to 1000.00V. Observe a DMM readout of 10.0000.

n. Adjust the signal and reference voltage source outputs to zero and disconnect them from the DMM. Connect the DMM red and black leads together.

INTERFACE CHECKOUT

PRINT OUTPUT

To perform the DMM print output operational checkout connect an external recorder, suitable for use with the type of Print Output Assemblies installed in the

DMM, to rear panel connectors J2, J3, and J4. Refer to the Print Output Assembly schematic diagrams for connector pin numbers and printout logic.

1. DMM Constant Track Mode

   a. Position the front panel switches to the initial positions (table 3-2).

   b. Connect the DMM red and black leads to the DC voltage source. Adjust the voltage output to 10.0000V.

   c. While increasing the signal voltage to 15V in 1V steps, observe that the DMM tracks the signal and provides front panel readout of the changes but no printouts.

   d. With the DMM nulled on 15V momentarily depress the PRINT FP (Force Print) switch and observe a printout on the recorder of the DMM front panel readout.

   e. Depress the PRINT AUTO switch.

   f. While decreasing the signal voltage to 10V in 1V steps, observe that there is a new readout and printout each time the DMM nulls.

   g. Depress the PRINT HOLD switch.

   h. While increasing the signal voltage to 15V in 1V steps observe that the DMM readout remains 10.0000 and there are no printouts.

   i. Momentarily depress the PRINT REB switch and observe a readout and printout of 15.000.

   j. While decreasing the signal voltage to 10V observe that the DMM readout remains 15.000 and there are no printouts.

2. DMM Repetitive Track Mode

   a. Depress the PRINT AUTO switch. Rotate the REPETITIVE MODE switch clockwise to On.

   b. Adjust the REPETITIVE MODE switch until there is a printout about once per second.

   c. Slowly rotate the REPETITIVE MODE switch clockwise and observe that the printouts-per-second increase until there are about five per second.

   d. Adjust the DC voltage source output to zero and disconnect from the DMM. Rotate the REPETITIVE MODE switch to OFF.

REMOTE CONTROL

Remote Buffer Assembly Installed:

In figure 3-3, when a Remote Control Unit is connected to the DMM instead of the test setup:

1. A ground level signal is applied through terminal 45 to signify to the Remote Unit the DMM is in Remote configuration. A +5 volts applied through terminal 45 signifies the DMM is not in Remote configuration.

2. At the option of the operator, terminal 16 can have +5 volts applied from the Remote Control Unit for Remote Buffer Assembly relay coil supply. The DMM coil supply voltage would not be used under this condition.

Remote (Non-Buffered) Assembly Installed:

In figure 3-4 when a Remote Control Unit is connected to the DMM instead of the test setup:

1. A ground level signal is applied through terminal 45 to signify to the Remote Unit the DMM is in Remote configuration. A +5 volts applied through terminal 45 signifies the DMM is not in Remote configuration.

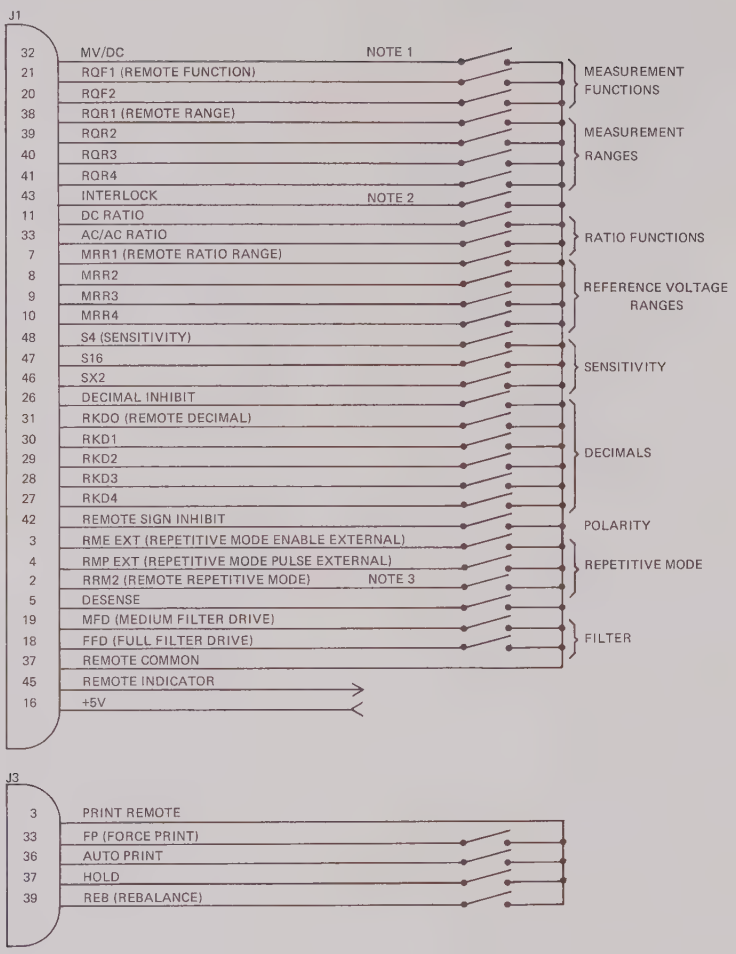
2. The DMM common is applied through terminal 50 to the Remote Unit.

Remote Checkout

Table 3-3 is the remote programming function and range logic truth table.

To perform the DMM remote control operational checkout (in the following procedures do not remove programs until so directed):

1. If a Remote Control Unit is available connect it to the DMM rear panel connectors J1 and J3. Con-



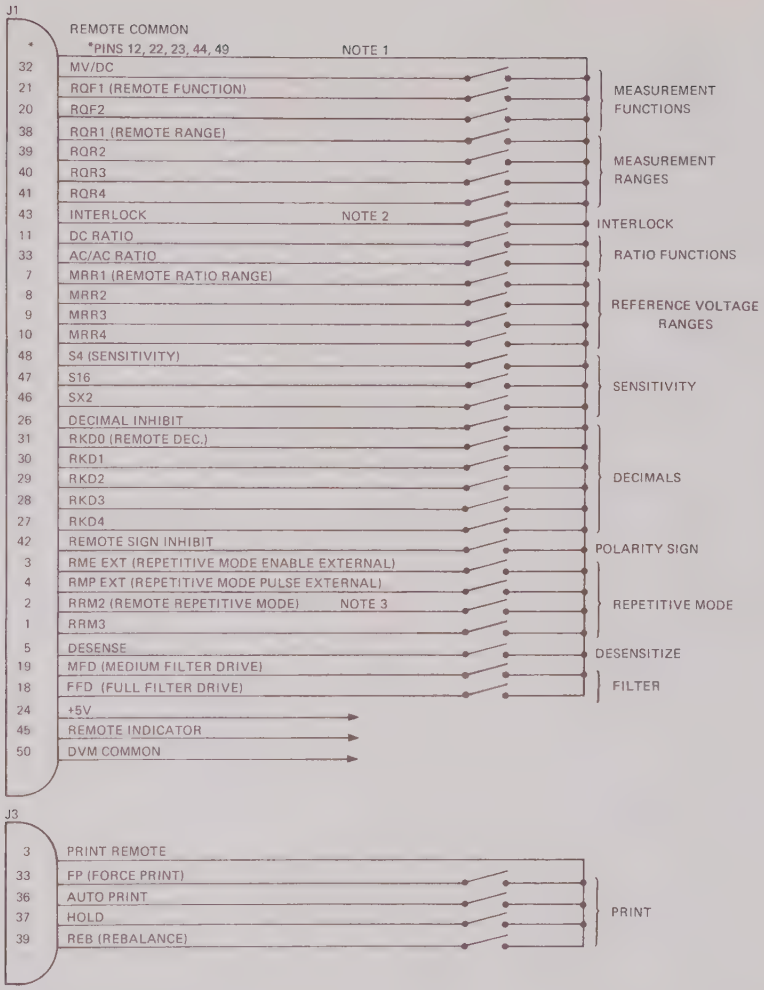
NOTES: 1. The DMM:

a. Is in FUNCTION DC when no other function is programmed.
b. Is in Autorange when a manual range is not programmed.
c. Is in SENSITIVITY 1 when no other degree of Sensitivity is programmed.
d. Input signal is unfiltered until either MFD or FFD is programmed.
e. Is in PRINT TRACK mode when no other Print mode is programmed.

2. Interlock is not normally jumpered on the Remote Buffer board to Remote Common and is not programmed. If it is desired to program Interlock after a function has been programmed, the jumper must be installed. (Refer to the Remote Buffer Assembly schematic diagram.) Interlock can then be programmed each time the Interlock switch is closed.

3. The Repetitive Mode Print Enable pulse generated by the Units Decade and Control Logic Assembly is normally 90 milliseconds wide. When RRM2 is programmed the pulse width is reduced to 60 milliseconds.

Figure 3-3. Remote (Buffered) Assembly Operational Checkout Test Setup.



NOTES: 1. The DMM:

a. Is in FUNCTION DC when no other function is programmed.
b. Is in Autorange when a manual range is not programmed.
c. Is in SENSITIVITY 1 when no other degree of Sensitivity is programmed.
d. Input signal is unfiltered until either MFD or FFD is programmed.
e. Is in PRINT TRACK mode when no other print mode is programmed.

2. Interlock is not normally jumpered on the Remote board to Remote Common and is not programmed. If it is desired to program Interlock after a function has been programmed, the jumper must be installed. (Refer to the Remote Assembly schematic diagram.) Interlock can then be programmed each time the Interlock switch is closed.

3. The Repetitive Mode Print Enable pulse generated by the Units Decade and Control Logic Assembly is normally 90 milliseconds wide. When RRM2 is programmed the pulse width is reduced to 60 milliseconds and RRM3 and RRM2 reduce the pulse width to 40 milliseconds.

Figure 3-4. Remote (Non-Buffered) Assembly Operational Checkout Test Setup.

nect the Remote Unit as shown in figure 3-3 if a Remote Buffer Assembly is installed in the DMM, or in figure 3-4 if a Remote (non-buffered) Assembly is installed. If a Remote Control Unit is not available, using two 50-pin Amphenol connectors connect the test setup as shown in figure 3-3 or figure 3-4, as applicable.

NOTE

When the instrument is changed from local to remote control, the front panel switches, including REPETITIVE MODE will remain in the same configuration they were in at the time of the change. Except for the POWER switch, they will be disabled. When a change from remote to local control is made, the switches are again enabled. The DMM, however, will remain in the last function and range programmed while in remote control.

2. Connect the DMM red and black leads together. Depress the REMOTE CONTROL switch.

3. Observe that the DMM front panel DC function indicator is lighted and the front panel readout is .XXXXX.

NOTE

If a Remote Buffer Assembly is installed or if a Remote Assembly is installed with the INTERLOCK feature activated, it will be necessary to program INTERLOCK each time a function has been programmed. The functions are MV/DC, RQF1, RQF2, DC Ratio, and AC/AC Ratio.

4. DC Millivolt Measurement

   a. Program MV/DC.

   b. Program RQR1, RQR3, and RQR4. Observe that the DC and MV function indicators are lighted and the readout is X.XXXX.

   c. Program RQR2. Observe that the DC and MV indicators are lighted and the readout is XX.XXX.

5. DC Voltage Measurement

   a. Remove program MV/DC.

   b. Remove programs RQR1, RQR2, and RQR3. Observe that the DC indicator is lighted, the MV indicator is extinguished, and the readout is .XXXXX.

   c. Program RQR1. The readout is X.XXXX.

   d. Program RQR2. The readout is XX.XXX.

   e. Remove programs RQR1, RQR2. Program RQR3. The readout is XXX.XX.

6. AC Voltage Measurement

   a. Remove program RQR3. Program RQF1. Observe that the AC indicator is lighted, the DC indicator is extinguished, and the readout is .XXXXX.

   b. Repeat step 5c, step 5d, and then step 5e.

7. LOΩ Ohms and Kilohms Measurement

   a. Remove program RQR3. Program RQF2. Observe that the LOΩ and Ω indicators are lighted, the AC indicator is extinguished, and the readout is .XXXXX.

   b. Repeat steps 5c and 5d.

   c. Remove programs RQR1 and RQR2. Program RQR3. Observe that the LOΩ and KΩ indicators are lighted, the Ω indicator is extinguished, and the readout is .XXXXX.

   d. Program RQR1. The readout is X.XXXX.

8. HIΩ Kilohms and Megohms Measurement

   a. Remove programs RQF1, RQR1, RQR2, and RQR3. Observe that the HIΩ and KΩ indicators are lighted, the LOΩ indicator is extinguished, and the readout is .XXXXX.

   b. Repeat steps 5c and 5d.

   c. Remove programs RQR1 and RQR2. Program RQR3. Observe that the HIΩ and MΩ indicators

are lighted, the KΩ indicator is extinguished, and the readout is .XXXXX.

d. Repeat steps 5c and 5d.

9. DC/DC Ratio Measurement

a. Remove all programs except RQR4. Observe that the DC indicator is lighted and the readout is .XXXXX.

b. Program DC RATIO and MRR1. Observe that the DC and RATIO indicators are lighted and the readout is .XXXXX.

c. Program RQR3. The readout is XXX.XX.

d. Remove programs MRR1 and RQR3. Program MRR2. The readout is .XXXXXX.

e. Program RQR3. The readout is XX.XXX.

f. Remove programs MRR2 and RQR3. Program MRR3 and RQR1. The readout is .XXXXXX.

g. Remove program RQR1. Program RQR3. The readout is X.XXXX.

10. AC/AC Ratio Measurement

a. Remove all programs except RQR4. Program RQF1, AC/AC ratio and MRR1. Observe the AC and RATIO indicators are lighted and the readout is .XXXXX.

b. Program RQR3. The readout is XXX.XX.

c. Remove programs MRR1 and RQR3. Program MRR2. The readout is .XXXXXX.

d. Program RQR3. The readout is XX.XXX.

e. Remove programs MRR2 and RQR3. Program MRR3 and RQR1. The readout is .XXXXXX.

f. Remove program RQR1. Program RQR3. The readout is X.XXXX.

g. Remove programs MRR3 and RQR3. Program MRR4, RQR1, and RQR2. The readout is .XXXXXX.

h. Remove programs RQR1 and RQR2. Program RQR3. The readout is .XXXXX.

11. DC/AC Ratio Measurement

a. Remove programs RQF1, MRR4 and RQR3. Program MRR2. Observe that the DC and RATIO indicators are lighted, the AC indicator is extinguished and the readout is .XXXXXX.

b. Program RQR3. The readout is XX.XXX.

12. AC/DC Ratio Measurement

a. Remove all programs except RQR4. Program RQF1, DC RATIO, and MRR2. Observe that the DMM AC and RATIO indicators are lighted, the DC indicator is extinguished, and the readout is .XXXXXX.

b. Program RQR3. The readout is XX.XXX.

c. Remove all programs.

13. Sensitivity

a. Connect the DMM red and black leads to the DC voltage source. Adjust the voltage source output to 5.0000V. Observe a DMM readout of 5.0000.

b. Program S16 and SX2. Change the voltage source output until the DMM readout changes one digit. Observe that the voltage source output has changed about 3200 microvolts.

c. Remove programs SX2 and S16.

14. Decimal Control and Polarity Sign Inhibit

a. Program DEC INHIBIT and observe there is no decimal in the DMM readout.

b. Successively program and then remove RKD0 through RKD4 while observing the decimal point indicator is properly positioned in each range.

c. Program and then remove REMOTE SIGN INHIBIT while observing the readout polarity sign disappears and then reappears.

15. Filter Control

a. Decrease the voltage source output to 1V in 1V steps while observing the rate at which the numerical values of the readout change.

b. Program MFD. Increase the voltage source output to 5V in 1V steps while observing the readout rate of change is slower than in step 15a.

c. Remove program MFD. Program FFD. Decrease the voltage source output to 1V in 1V steps while observing the readout rate of change is slower than in step 15b.

16. Print Output and Desense

a. While varying the voltage source output, momentarily program FP and observe there is only a single printout.

b. Program HOLD. Adjust the voltage source output to 5V while observing no change in the DMM readout and no printout.

c. Momentarily program REB. Observe the readout and printout is 5V.

d. Reduce the voltage source output to 1V. Observe the readout has remained at 5V and there was no printout.

e. Remove program HOLD. Program AUTO PRINT.

f. Increase the voltage source output to 5V in 1V steps. Observe there is a new readout and printout each time the DMM nulls.

g. Program DESENSE. Disconnect one DMM lead from the voltage source. Observe that a 3 appears in the desensitivity column of the printout.

h. Remove program DESENSE. Reconnect the DMM lead to the voltage source.

17. Repetitive Mode

a. Program RME EXT.

b. Decrease the voltage source output to 1V in 1V steps while momentarily programming RMP EXT at each step. Observe that at each step the DMM provides a readout and printout of the new voltage value only when RMP EXT is programmed.

c. Remove all programs. Reduce the voltage source output to zero and disconnect the source from the DMM. Connect the DMM red and black leads together.

Table 3-3. Remote Programming Function and Range Logic Truth Table.

LOGIC LEVEL: 0 = 0V 1 = +5V					CONTACT CLOSURE: 0 = Energized 1 = De-energized			
					PROGRAM			
FUNCTION					RQF2	RQF1		
DC					1	1		
AC					1	0		
HI OHMS					0	1		
LO OHMS					0	0		
MEASUREMENT RANGE					RQR4	RQR3	RQR2	RQR1
VOLTS		OHMS						
DC	AC	LO	HI	MEG				
1	1	1	1k		0	1	1	1
10	10	10	10k		0	1	1	0
100	100	100	100k		0	1	0	0
1000	1000	1000	1M		0	0	1	1
.01		10k	10M		0	0	1	0
.1				100	0	0	0	0
REFERENCE VOLTAGE RANGES					MRR4	MRR3	MRR2	MRR1
1					1	1	1	0
10					1	1	0	1
100					1	0	1	1
1000					0	1	1	1

SECTION IV
CALIBRATION AND VERIFICATION OF SPECIFICATIONS

GENERAL

This section contains procedures for instrument calibration and verifying of electrical specifications. The procedures assume that all optional assemblies are inserted in the instrument. Omit procedural steps applicable to assemblies not in the instrument.

Accuracy of calibration and verification depends on the use of quality test equipment. Test equipment employed should be as good or better than the equipment specified for use in the procedures. For example, if an accurate DC voltage calibrator capable of supplying 1000 volts is not available a lower voltage may be substituted. The accuracy of calibration and verification of specifications will be proportionately less, however, as the voltage is decreased.

Prior to calibration or verification, the instrument must be placed in the environment of the work area for sufficient time to allow the internal temperature to stabilize. A stabilizing time of one hour for every 10°C change in temperature is required.

The accuracy of the internal reference supply is within specification in a relatively short time. If ultimate accuracy is to be realized, however, complete stabilization is necessary prior to calibration. When power has been removed from the instrument for an appreciable time, a 90-minute warmup period must be allowed for complete instrument stabilization.

NOTE

The front panel green lead must be connected to the black lead while performing the following calibration and verification procedures.

CALIBRATION PROCEDURES

The following equipment is required to perform the calibration procedures:

1. Five-digit test Digital Voltmeter (DVM)(six digits in overrange). Cimron Model 6753 or equivalent.

2. DC Voltage Calibrator, 1 mV to 1000V. Fluke Model 332A or equivalent.

3. AC Voltage Calibrator, 1 to 1000 VAC and 100 Hz to 20 kHz. Hewlett Packard Model 745A AC Calibrator and Hewlett Packard Model 746A High Voltage Amplifier, or equivalent.

4. Voltage Divider, ESI Model RV722 or equivalent.

5. Ten resistors:

1 Ω ± 0.005%	50 kΩ ± 5%
10 Ω ± 0.002%	100 kΩ ± 0.002%
100 Ω ± 0.002%	1 MΩ ± 0.002%
1 kΩ ± 0.002%	10 MΩ ± 0.002%
10 kΩ ± 0.002%	100 MΩ ± 0.02%

Remove top cover of the Model 6853 DMM. Calibration controls and test points are identified on the top shield (figure 4-1) beneath the cover and are accessible through apertures in the shield. In addition, on the front panel there are two screwdriver-adjustment zero controls that are used during calibration. To the viewer's left there is the DC zero control located between the AC and RATIO function indicators and to the right there is the mV zero control located between the MV and REMOTE function indicators.

NOTE

During the calibration, if the values specified in the procedures cannot be attained, perform the operational adjustments described in Section VI.

BASIC DC INSTRUMENT

To perform the basic DC instrument calibration procedure:

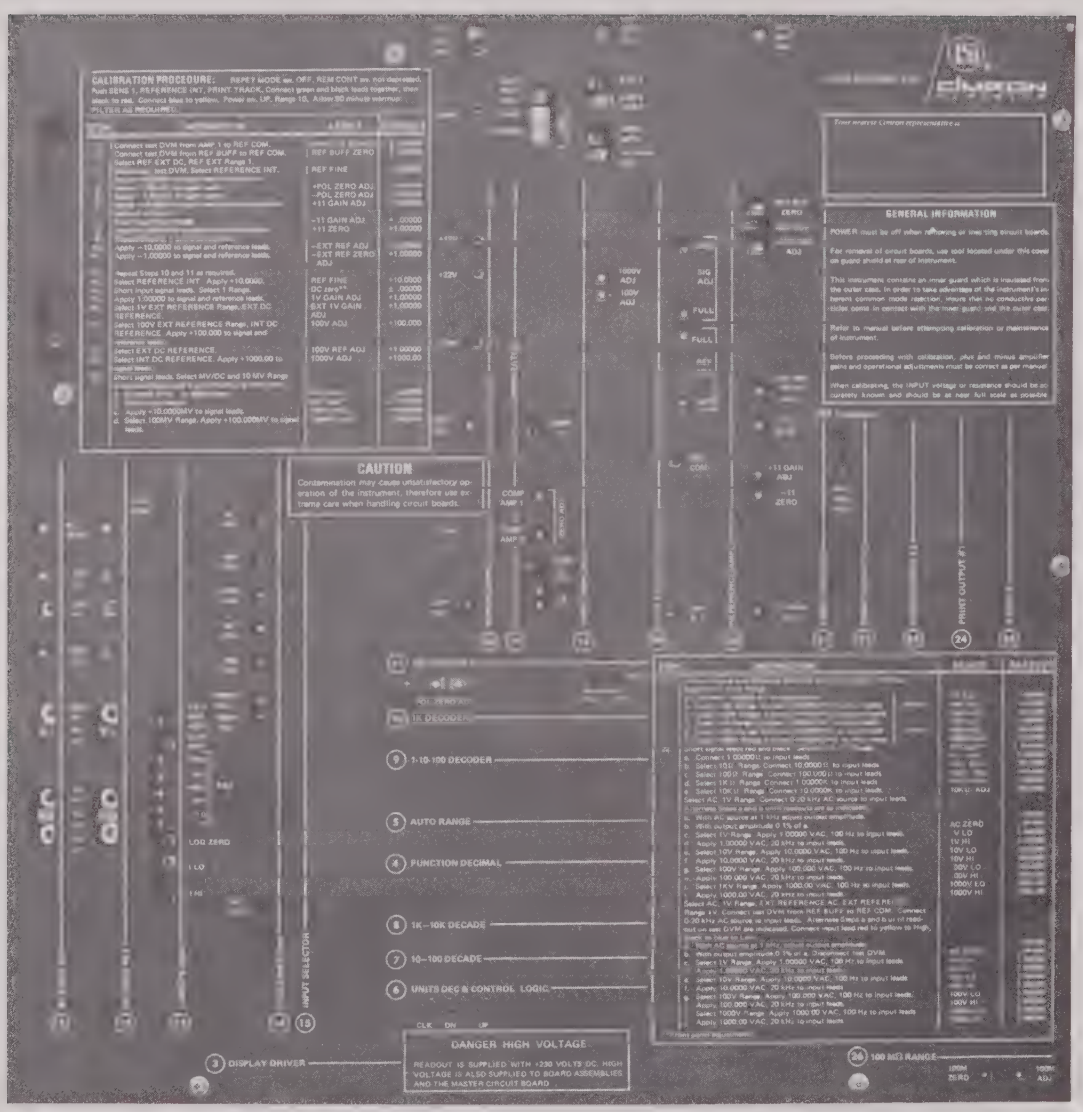

CALIBRATION PROCEDURE:
GENERAL INFORMATION
CAUTION
Contamination may cause unsatisfactory operation of the instrument, therefore use extreme care when handling circuit boards.
DANGER HIGH VOLTAGE
READOUT IS SUPPLIED WITH +230 VOLTS DC. HIGH VOLTAGE IS ALSO SUPPLIED TO BOARD ASSEMBLIES AND THE MASTER CIRCUIT BOARD.
1K DECODER
1-10-100 DECODER
AUTO RANGE
FUNCTION DECIMAL
1K—10K DECADE
10—100 DECADE
UNITS DEC & CONTROL LOGIC
DISPLAY DRIVER
100 MΩ RANGE
INPUT SELECTOR
PRINT OUTPUT #1

Figure 4-1. Model 6853 Top Shield.

1. Position the front panel switches to the initial setting (Table 3-2). Connect the green and black leads together and then the black and red (signal input) leads together. Connect the blue and yellow (reference input) leads together. Allow a 90-minute warmup period before proceeding.

NOTE

During Calibration operate both the test DVM and the Model 6853 DMM filter switches as required to stabilize readouts.

2. Momentarily depress the front panel RANGE UP switch.

3. Adjust the test DVM for DC measurement on the 10V range. Connect the test DVM between AMP 1 and REF COM (figure 4-1) with the test DVM high signal input connector to AMP 1.

4. Vary AMP 1 ZERO ADJ control to obtain a test DVM ±0.0000 readout.

5. Connect the DC Voltage Calibrator to the DMM signal input leads with the red lead to the Voltage Calibrator + output and the black lead to the – output. Apply 10.0000V to the DMM.

6. Vary 10V GAIN ADJ control to obtain a test DVM –10.0000 readout. Disconnect the DC Voltage Calibrator and connect the DMM signal input leads together.

7. Change the test DVM high signal input connector from AMP 1 to REF BUF. On instrument being calibrated, depress REFERENCE EXT DC and REFERENCE EXT 1 switches.

8. Vary REF BUF ZERO control to obtain a test DVM ±.00000 readout.

CAUTION

Do not apply more than 10 VDC to the reference input leads. Failure to observe this caution will damage the Reference Amplifier Assembly.

9. Connect the DMM reference input leads to the test setup (figure 4-2) with the yellow lead to the Voltage Divider + output and the blue lead to the Voltage Divider – output. Depress REFERENCE EXT 10 switch. Apply 10.0000V to the DVM.

NOTE

Because of possible interaction, repeat steps 10 through 15 as required to obtain the indicated readouts.

10. Connect the test DVM high signal input lead to REF +11V.

11. Vary +11 GAIN ADJ control for a test DVM +10.9999 ±1 digit readout.

12. Connect the test DVM high signal input lead to REF –11. Vary –11 GAIN ADJ control for a test DVM –10.9999 ±1 digit readout.

13. Apply 1.00000V to the DMM.

14. Connect the test DVM high signal input lead to REF +11V. Vary +11 ZERO control for a test DVM +1.09999 ±1 digit readout.

15. Connect the test DVM high signal input lead to REF –11V. Vary –11V ZERO control for a test DVM –1.09999 ± readout.

16. Disconnect the test DVM. Depress the DMM REFERENCE INT switch.

17. Connect the test setup shown in figure 4-2.

18. Apply 10.0000V to the DMM. Vary the REF FINE control for a DMM +10.0000 readout.

19. Apply 1.00 mV to the DMM. Vary the POL ZERO ADJ + control for a +0.0010 readout.

20. Reverse the DMM red and black lead connections to the Voltage Divider. Apply 1.00 mV to the DMM. Vary the POL ZERO ADJ –control for a –0.0010 readout. Reverse the red and black leads to the voltage divider.

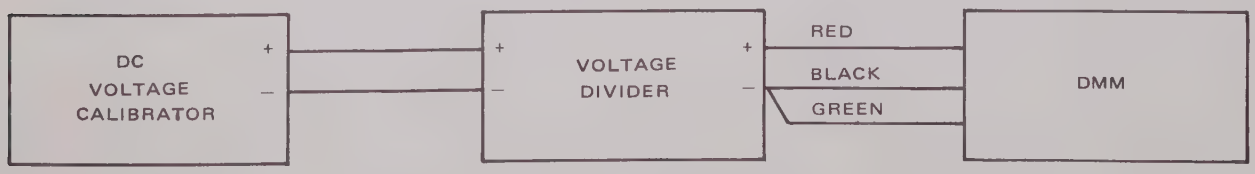


Figure 4-2. DC Calibration Test Setup.

21. Depress REFERENCE EXT 10 switch. Connect the DMM reference inputs leads to the test setup (figure 4-2) with the yellow lead to the Voltage Divider + output and the blue lead to the Voltage Divider – output.

NOTE

Because of possible interaction, repeat steps 22, 23, and 24 as required to obtain the indicated readouts.

22. Apply 10.0000V to the DMM. Depress REFERENCE EXT DC switch. Vary +11 GAIN ADJ control for a +1.00000 readout.

23. Disconnect the signal input leads from the Voltage Divider and connect them together. Vary the –11 GAIN ADJ control for a +.00000 readout.

24. Reconnect the signal input leads to the voltage divider with the red lead to the + output. Apply 1.00000V to the signal and reference input leads. Vary the +11 ZERO control for a +1.00000 readout.

NOTE

Repeat steps 25 and 26 as required to obtain indicated readouts.

25. Reverse the DMM red and yellow and the black and blue lead connections to the Voltage Divider outputs. Apply 10.0000V to the DMM. Vary –EXT REF ADJ control for a +1.00000 readout.

26. Apply 1.00000 to the DMM. Vary –EXT REF ZERO ADJ for a +1.00000 readout.

27. Reverse the DMM red and yellow and the black and blue lead connections to the Voltage Divider outputs. Depress the REFERENCE INT switch.

28. Apply 10.0000V to the DMM. Vary the REF FINE control for a +10.0000 readout.

29. Disconnect the signal input leads from the Voltage Divider and connect them together. Depress front panel RANGE AUTO switch. Vary the DMM front panel DC zero screwdriver adjustment for a ±.00000 readout.

30. Reconnect the signal input leads to the Voltage Divider outputs, with the red lead to +. Apply 1.00000V to the DMM. Vary the 1V GAIN ADJ for a +1.00000 readout.

31. Depress the REFERENCE EXT DC and REFERENCE EXT 1 switches. Vary the EXT 1 GAIN ADJ control for a +1.00000 readout.

32. Depress the REFERENCE INT and REFERENCE EXT 100 switches. Apply 100.000V to the DMM. Vary the 100V ADJ control for a +100.000 readout.

33. Depress REFERENCE EXT DC switch. Vary the 100V REF ADJ control for a +1.00000 readout.

34. Reduce the DC Voltage Calibrator output to zero. Disconnect the test setup. Do not connect the DMM yellow and blue leads together.

35. Depress the REFERENCE INT switch. Connect the DMM signal input leads to the DC Voltage Calibrator with the red lead to the Calibrator + output.

36. Apply 1000.00V to the DMM. Vary the 1000V ADJ control for a +1000.00 readout.

37. Reduce the DC Voltage Calibrator output to zero. Disconnect the DMM signal input leads from the Calibrator and connect them together.

HIΩ-MV CONVERTER

Millivolts Section

CAUTION

Do not apply more than 125V to the signal input leads when the DMM is in the MV/DC mode. Failure to observe this caution will open the fuse in the millivolt section of the HIΩ-MV Converter Assembly.

1. Depress front panel FUNCTION MV/DC and RANGE AUTO switches.

NOTE

Repeat steps 2 and 3 as required to obtain readouts as close as possible to 0.0000.

2. Depress the RANGE DN switch. Connect a 50 kΩ resistor to the signal input leads. Vary the MV NULL control for a 0.0000 readout.

3. Connect the signal input leads together. Vary the front panel mV zero screwdriver adjustment for a readout of ±0.0000.

4. Connect the test setup as shown in figure 4-2. Apply 10.0000 mV to the DMM. Vary the 10 MV ADJ control for a +10.0000 readout.

5. Momentarily depress the front panel RANGE UP switch. Apply 100.000 mV to the DMM. Vary the 100MV ADJ Control for a +100.000 readout. Disconnect the test setup.

Ohms Section

CAUTION

Do not apply a voltage to the signal input leads when the DMM is in the HI Ω measurement mode. Failure to observe this caution may open the fuse in the ohms input circuit.

1. Depress the RANGE AUTO switch. Repeatedly depress the FUNCTION STEP switch until the HIΩ and KΩ function indicators are lighted. Depress the FUNCTION INT LOK switch.

NOTE

When using 4-wire measurement, connect the red and yellow and black and blue leads to the resistance being measured exactly as shown in figure 3-2.

2. Connect a 1 kΩ ±0.002% resistor to the input leads. Vary the 1K ADJ control for a 1.00000 readout.

3. Momentarily depress the RANGE UP switch. Connect a 10 kΩ ±0.002% resistor to the input leads. Vary the 10K ADJ control for a 10.0000 readout.

NOTE

When performing the calibration adjustment at the 100 kΩ and higher ranges, care should be taken not to touch any part of the test setup with anything except the calibration tool. If a decade resistance box is being used, when measuring resistances in the 100 kΩ and higher ranges ensure that the resistance box is grounded and that the leads between the box and the DMM input leads are kept as short as possible. These precautions reduce the effect of hum pickup which could cause offset or rattling.

4. Momentarily depress the RANGE UP switch. Connect a 100 kΩ ±0.002% resistor to the input leads. Vary the 100K ADJ control for a 100.000 readout.

5. Momentarily depress the RANGE UP switch. Connect a 1 MΩ ±0.002% resistor to the input leads. Vary the 1M ADJ control for a 1.00000 readout.

6. Momentarily depress the RANGE UP switch. Connect a 10 MΩ ±0.002% resistor to the input leads. Vary the 10M ADJ control for a 10.0000 readout.

7. Momentarily depress the RANGE UP switch. Connect a 100 MΩ ±0.02% resistor to the input leads. Vary the 100M ADJ control for a 100.000 readout. Disconnect the resistor from the input leads.

LOW OHMS CONVERTER

CAUTION

Do not apply a voltage to the signal input leads when the DMM is in the LOΩ measurement mode. Failure to observe this caution may damage the Low Ohms Converter Assembly.

1. Connect the signal input leads together. Depress the RANGE AUTO switch. Repeatedly depress the FUNCTION STEP switch until the LOΩ and Ω function indicators are lighted. Depress the FUNCTION INT LOK switch.

2. Vary the front panel mV zero screwdriver adjustment for a ±0.0000 readout.

3. Connect a 1Ω ±0.005% resistor to the input leads (see figure 3-2). Vary the 1Ω ADJ control for a 1.00000 readout.

4. Momentarily depress the RANGE UP switch. Connect a 10Ω ±0.002% resistor to the input leads. Vary the 10Ω ADJ control for a 10.0000 readout.

5. Momentarily depress the RANGE UP switch. Connect a 100Ω ±0.002% resistor to the input leads. Vary the 100Ω ADJ control for a 100.000 readout.

6. Momentarily depress the RANGE UP switch. Connect a 1 kΩ ±0.002% resistor to the input leads. Vary the 1KΩ ADJ control for a 1.00000 readout.

7. Momentarily depress the RANGE UP switch. Connect a 10 kΩ ±0.002% resistor to the input leads. Vary the 10KΩ ADJ control for a 10.0000 readout. Disconnect the resistor from the input leads.

CAUTION

Between 50 Hz and 20 kHz, do not apply more than 1000V rms to either the AC Input Signal Converter or the AC Reference Voltage Converter. Between 20 kHz and 50 kHz, do not apply more than 500V rms. Between 50 kHz and 100 kHz, do not apply more than 250V rms. Failure to observe this caution may result in damage to the instrument.

AC SIGNAL INPUT CONVERTER

1. Depress the RANGE AUTO switch. Repeatedly depress the FUNCTION STEP switch until the AC function indicator is lighted. Depress the FUNCTION INT LOK switch.

2. Connect the test setup shown in figure 4-3, with the DMM red lead to AC Calibrator OUTPUT HI and DMM black lead to OUTPUT LO.

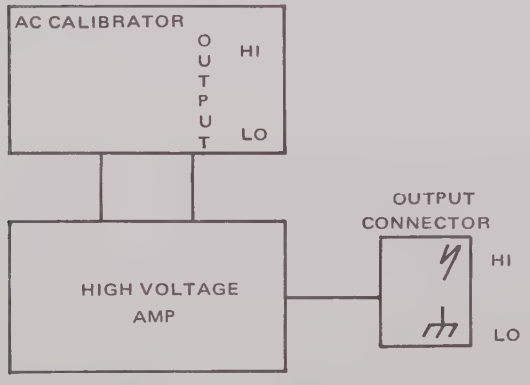
NOTE

Repeat steps 3 and 4 as required to obtain the indicated readout.

3. Adjust the AC source output frequency to 1 kHz and output voltage amplitude for a DMM readout of 1.00000.

4. Adjust the AC source output voltage amplitude to 0.1% of step 3. Vary the AC ZERO control for a .00100 readout.

5. Apply 1.00000V, 100 Hz to the DMM. Vary the 1V LO control for a 1.00000 readout.



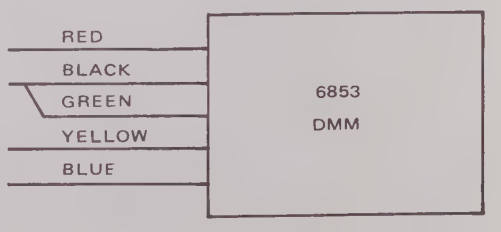


Figure 4-3. AC Calibration Test Setup.

6. Apply 1.00000V, 20 kHz to the DMM. Vary the 1V HI control for a 1.00000 readout.

7. Momentarily depress the RANGE UP switch. Apply 10.0000V, 100 Hz to the DMM. Vary the 10V LO control for a 10.0000 readout.

8. Apply 10.0000V, 20 kHz to the DMM. Vary the 10V HI control for a 10.0000 readout.

9. Momentarily depress the RANGE UP switch. Apply 100.000V, 100 Hz to the DMM. Vary the 100V LO control for a 100.000 readout.

10. Apply 100.000V, 20 kHz to DMM. Vary the 100V HI control for a 100.000 readout.

11. Reduce the AC Calibrator output to zero. Momentarily depress the RANGE UP switch. Connect the DMM red and black leads to the High Voltage Amp (figure 4-3) with the red lead to the high output.

12. Apply 1000.00V, 100 Hz to the DMM. Vary the 1000V LO control for a 1000.00 readout.

13. Apply 1000.00V, 20 kHz to the DMM. Vary the 1000V HI control for a 1000.00 readout. Adjust the High Voltage Amp output to zero.

AC REFERENCE VOLTAGE CONVERTER

1. Depress RANGE AUTO, REFERENCE EXT AC, and REFERENCE EXT 1 switches.

2. Adjust the test DVM for DC measurement on the 10V range. Connect the test DVM between REF BUF and REF COM with the test DVM high signal input connected to REF BUF.

3. Connect the DMM red and yellow leads together and connect the black and blue leads together.

4. Connect the test setup shown in figure 4-3 with the red-yellow leads connected to the AC Calibrator OUTPUT HI and blue-black leads to OUTPUT LO.

NOTE

Repeat steps 5 and 6 as required to obtain the indicated readouts.

5. Adjust the AC source output frequency to 1 kHz and output voltage amplitude for a test DVM readout of 1.00000.

6. Adjust the AC source output voltage amplitude to 0.1% of step 5. Vary the AC ZERO control for a test DVM readout .00100. Disconnect the test DVM.

7. Apply 1.00000V, 100 Hz to the DMM. Vary the 1V LO control for a 1.00000 readout.

8. Apply 1.00000V, 20 kHz to the DMM. Vary the 1V HI control for a 1.00000 readout.

9. Momentarily depress the RANGE UP switch. Depress the REFERENCE EXT 10 switch.

10. Apply 10.0000V, 100 Hz to the DMM. Vary the 10V LO control for a 1.00000 readout.

11. Apply 10.0000V, 20 kHz to the DMM. Vary the 10V HI control for a 1.00000 readout.

12. Momentarily depress the RANGE UP switch. Depress the REFERENCE EXT 100 switch.

13. Apply 100.000V, 100 Hz to the DMM. Vary the 100V LO control for a 1.00000 readout.

14. Apply 100.000V, 20 kHz to the DMM. Vary the 100V HI control for a 1.00000 readout.

15. Reduce the AC Calibrator output to zero. Momentarily depress the RANGE UP switch. Depress the REFERENCE EXT 1K switch. Connect the red-yellow and black-blue leads to the High Voltage Amp, with the red-yellow lead to the high output.

16. Apply 1000.00V, 100 Hz to the DMM. Vary the 1000V LO control for a 1.00000 readout.

17. Apply 1000.00V, 20 kHz to the DMM. Vary the 1000V HI control for a 1.00000 readout.

18. Adjust the High Voltage Amp output to zero. Disconnect the test setup. Connect the DMM red and black leads together.

VERIFICATION OF SPECIFICATIONS

If the readings and tolerances specified in these verification procedures cannot be attained, it is recommended that the instrument be re-calibrated.

The following equipment is required to verify the specifications:

NOTE

To avoid damaging the DMM, do not operate the test equipment outside of specifications.

1. AC Voltage Calibrator, 0.01 to 1000VAC and 50 Hz to 100 kHz. Hewlett Packard Model 745A Calibrator and Hewlett Packard Model 746A High Voltage Amplifier or equivalent.
2. Voltage Divider, ESI Model RV722 or equivalent.
3. DC Voltage Calibrator, Fluke Model 332A or equivalent.
4. Ohmmeter, any model.
5. Mercury Battery 1.35V.
6. Switch, SPST.
7. Eleven Resistors:

1Ω ± 0.005%	100 kΩ ± 0.1%
10Ω ± 0.002%	100 kΩ ± 0.002%
100Ω ± 5%	1 MΩ ± 0.002%
100Ω ± 0.002%	10 MΩ ± 0.002%
1 kΩ ± 0.002%	100 MΩ ± 0.02%
10 kΩ ± 0.002%	

ACCURACY

DC Voltage Measurement

To verify the DC voltage measurement accuracy:

1. Connect the signal input leads together. Position the front panel switches to the initial setting (table 3-2).
2. Repeatedly depress the FUNCTION STEP switch until the DC function indicator lights. Depress the FUNCTION INT LOK switch.
3. If the front panel readout is not .00000, vary the DC zero screwdriver adjustment located between the front panel AC and RATIO function indicators to zero the readout.
4. Connect the DMM signal input leads to the DC Voltage Calibrator with the red lead to the positive terminal.
5. Apply the following voltages to the DMM and observe the indicated DMM front panel readouts:
   a. 1.00000V. Observe +1.00000 ± 16 digits.
   b. 10.0000V. Observe +10.0000 ± 6 digits.
   c. 100.000V. Observe +100.000 ± 6 digits.
   d. 1000.00V. Observe +1000.00 ± 6 digits.
6. Reduce the DC voltage source output to zero. Interchange the DMM signal input lead connections to the DC Voltage Calibrator. Repeat step 5 and observe that the readouts are the same except the polarity indication is negative.
7. Reduce the DC Voltage Calibrator output to zero and disconnect the test setup.

DC Millivoltage Measurement

CAUTION

Do not apply more than 125V to the signal input leads when the DMM is in the MV/DC mode. Failure to observe this caution may open the fuse in the millivolt section of the HIΩ-MV Converter Assembly.

To verify the DC millivoltage measurement accuracy:

1. Connect the signal input leads together. Depress the FUNCTION MV/DC switch and position the other front panel switches to the initial setting (table 3-2).

2. If the front panel readout is not 0.0000, vary the mV zero screwdriver adjustment located between the front panel MV and REMOTE function indicators to zero the readout.

3. Connect the test setup shown in figure 4-2.

4. Apply the following voltages to the DMM and observe the indicated DMM front panel readouts:

   a. 10.0000 mV. Observe +10.0000 ± 21 digits

   b. 100.000 mV. Observe +100.000 ± 11 digits.

5. Interchange the DMM signal input lead connections to the Voltage Divider. Repeat step 4 and observe that the readouts are the same except that the polarity indication is negative.

6. Disconnect the test setup.

AC Voltage Measurement

To verify the AC voltage measurement accuracy:

1. Connect the signal input leads together. Position the front panel switches to the initial setting (table 3-2).

2. Repeatedly depress the FUNCTION STEP switch until the AC function indicator lights. Depress the FUNCTION INT LOK switch.

3. Connect the test setup in figure 4-3 with the DMM red lead to the AC Calibrator OUTPUT HI connector and the DMM black and green leads to the OUTPUT LO connector.

CAUTION

Between 50 Hz and 20 kHz, do not apply more than 1000V rms to the DMM. Between 20 kHz and 50 kHz, do not apply more than 500V rms. Between 50 kHz and 100 kHz, do not apply more than 250V rms. Failure to observe this caution may result in damage to the instrument.

4. Apply 1.00000V to the DMM. Vary the AC source frequency between 50 Hz and 20 kHz and observe that the DMM front panel readout is 1.00000 ± 102 digits.

5. Vary the AC source frequency between 20 kHz and 50 kHz and observe that the readout is 1.00000 ± 205 digits.

6. Vary the AC source frequency between 50 kHz and 100 kHz and observe that the readout is 1.00000 ± 455 digits.

7. Apply 10.0000V to the DMM. Vary the AC source frequency between 50 Hz and 20 kHz and observe the readout is 10.0000 ± 102 digits.

8. Vary the AC source frequency between 20 kHz and 50 kHz and observe the readout is 10.0000 ± 205 digits.

9. Vary the AC source frequency between 50 kHz and 100 kHz and observe the readout is 10.0000 ± 455 digits.

10. Apply 100.000V to the DMM. Vary the AC source frequency between 50 Hz and 20 kHz and observe the readout is 100.000 ± 102 digits.

11. Vary the AC source frequency between 20 kHz and 50 kHz and observe the readout is 100.000 ± 205 digits.

12. Vary the AC source frequency between 50 kHz and 100 kHz and observe the readout is 100.000 ± 455 digits.

13. Reduce the AC Calibrator output to zero. Connect the DMM red and black leads to the High Voltage Amp (figure 4-3) with the red lead to the high output.

14. Apply 1000.00V to the DMM. Vary the AC source frequency between 50 Hz and 20 kHz and observe the readout is 1000.00 ± 102 digits.

15. Apply 500.00V to the DMM. Vary the AC source frequency between 20 kHz and 50 kHz and observe the readout is 500.00 ± 130 digits.

16. Apply 250.00V to the DMM. Vary the AC source frequency between 50 kHz and 100 kHz and observe the readout is 250.00 ± 155 digits.

17. Reduce the AC source output to zero and disconnect the test setup.

Resistance Measurement

To verify the resistance measurement accuracy:

1. Connect the signal input leads together. Position the front panel switches to the initial setting (table 3-2).

2. Repeatedly depress the FUNCTION STEP switch until the LOΩ and Ω function indicators light. Depress the FUNCTION INT LOK switch.

3. If the front panel readout is not 0.0000, vary the mV zero screwdriver adjustment located between the front panel MV and REMOTE function indicators to zero the readout.

CAUTION

Do not apply a voltage to the signal input leads when the DMM is in the LOΩ measurement mode. Failure to observe this caution may damage the Low Ohms Converter Assembly.

NOTE

When using 4-wire measurement, connect the red and yellow and black and blue leads to the resistance being measured exactly as shown in figure 3-2. Except for the green to black, do not stack the connectors.

4. Connect the following resistors to the DMM signal and reference input leads and observe the indicated DMM readouts:

   a. 1Ω ± 0.005%. Observe 1.00000 ± 30 digits.

   b. 10Ω ± 0.002%. Observe 10.0000 ± 20 digits.

   c. 100Ω ± 0.002%. Observe 100.000 ± 20 digits.

   d. 1 kΩ ± 0.002%. Observe 1.00000 ± 20 digits.

   e. 10 kΩ ± 0.002%. Observe 10.0000 ± 20 digits.

5. Disconnect the resistor from the DMM input leads. Repeatedly depress the FUNCTION STEP switch until the HIΩ and KΩ function indicators light. Depress the FUNCTION INT LOK switch.

CAUTION

Do not apply a voltage to the signal input leads when the DMM is in the HIΩ measurement mode. Failure to observe this caution will open the fuse in the ohms input circuit.

6. Connect the following resistors to the DMM signal and reference input leads and observe the indicated DMM readouts:

a. 1 kΩ ± 0.002%. Observe 1.00000 ± 16 digits.

b. 10 kΩ ± 0.002%. Observe 10.0000 ± 16 digits.

NOTE

When performing the resistance accuracy verification procedure in the 100 kΩ and higher ranges, care should be taken not to touch any part of the test setup while observing the readout. If a decade resistance box is being used, when measuring resistance in the 100 kΩ and higher ranges ensure that the resistance box is grounded and that the leads between the box and the DMM input leads are kept as short as possible. This precaution reduces the effect of hum pickup which could cause offset or rattling.

c. 100 kΩ ± 0.002%. Observe 100.000 ± 16 digits.

NOTE

In the 1 MΩ and higher ranges (2-wire measurement) connect the resistance only to the red and black leads.

d. 1 MΩ ± 0.002%. Observe 1.00000 ± 36 digits.

e. 10 MΩ ± 0.002%. Observe 10.0000 ± 56 digits.

f. 100 MΩ ± 0.02%. Observe 100.000 ± 200 digits.

6. Disconnect the resistance from the DMM leads.

DC/DC Ratio Measurement

To verify the DC/DC ratio measurement accuracy:

1. Connect the signal input leads together. Position the front panel switches to the initial setting (table 3-2).

2. Repeatedly depress the FUNCTION STEP switch until the DC function indicator lights. Depress the FUNCTION INT LOK switch.

3. If the front panel readout is not .00000, vary the DC zero screwdriver adjustment located between the front panel AC and RATIO function indicators to zero the readout.

4. Connect the test setup as shown in figure 4-4.

NOTE

If the optional DC Reference Voltage Attenuator is installed, do not perform steps 5 through 10. Perform steps 11 through 14.

CAUTION

Do not exceed 10 VDC reference input. Failure to observe this caution may damage the Reference Amplifier Assembly.

5. Adjust the DC Voltage Calibrator output to 1.00000V. Depress the REFERENCE EXT 1 and REFERENCE EXT DC switches.

6. Adjust the Voltage Divider to the following settings and observe the indicated DMM front panel readouts:

SETTING	READOUT
a. 100000	+ 1.00000 ± 16 digits
b. 50000	+ .50000 ± 14 digits
c. 10000	+ .10000 ± 12 digits

7. Depress the REFERENCE EXT 10 switch. Adjust the DC Voltage Calibrator output to 10.0000V.

8. Adjust the Voltage Divider to the following settings and observe the DMM readout:

SETTING	READOUT
a. 100000	+ 1.00000 ± 6 digits
b. 50000	+ .50000 ± 4 digits
c. 10000	+ .10000 ± 2 digits.

9. Interchange the DMM signal input lead connections to the Voltage Divider. Repeat steps 5 through

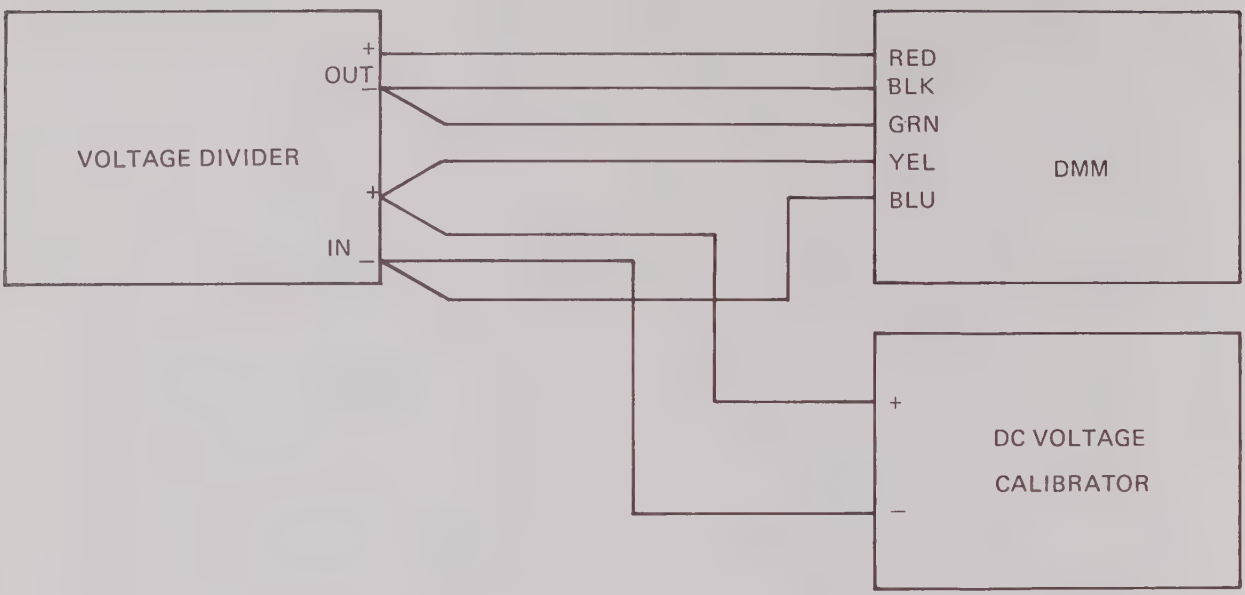


Figure 4-4. DC/DC Ratio Accuracy Test Setup.

8 and observe the readout values are the same but the polarity is negative.

10. Interchange the DMM reference lead connections to the Voltage Divider. Repeat steps 5 through 8 and observe the readout values are the same and the polarity is positive.

CAUTION

Do not exceed 100 VDC reference input. Failure to observe this caution may damage the Reference Amplifier Assembly.

11. Adjust the DC Voltage Calibrator output to 10V. Depress the REFERENCE EXT 100 and REFERENCE EXT DC switches. Adjust the DC Voltage Calibrator output to 100.000V.

12. Adjust the Voltage Divider to the following settings and observe the DMM readouts:

SETTING	READOUT
a. 100000	+ 1.00000 ± 5 digits
b. 50000	+ .50000 ± 4 digits
c. 10000	+ .10000 ± 4 digits.

WARNING

In steps 13 and 14 reduce the DC Voltage Calibrator Voltage to zero prior to interchanging connections. After the change has been made, adjust the Calibrator Voltage to 100.000V. Failure to observe this warning may result in injury or death to personnel.

13. Interchange the DMM signal input lead connections to the Voltage Divider. Repeat step 12 and

observe the readout values are the same but the polarity is negative.

14. Interchange the DMM reference lead connections to the Voltage Divider. Repeat step 12 and observe the readout values are the same and the polarity is positive.

15. Adjust the DC Voltage Calibrator output to zero and disconnect the test setup.

AC/AC Ratio Measurement

To verify the AC/AC ratio measurement accuracy:

1. Connect the signal input leads together. Position the front panel switches to the initial setting (table 3-2).

2. Repeatedly depress the FUNCTION STEP switch until the AC function indicator lights. Depress the FUNCTION INT LOK switch.

3. Refer to figure 4-3. Connect the DMM red and yellow leads to the High Voltage Amp high output terminal and the black, green, and blue leads to the low output terminal.

CAUTION

Between 50 Hz and 20 kHz do not apply more than 1000V rms to the DMM. Between 20 kHz and 50 kHz do not apply more than 500V rms. Between 50 kHz and 100 kHz do not apply more than 250V rms. Failure to observe this caution may result in damage to the instrument.

4. Adjust the AC Calibrator frequency to 1 kHz and voltage to 1000.00V.

5. Depress the REFERENCE EXT 1K and REFERENCE EXT AC switches. Observe a DMM readout of 1.00000 ± 60 digits. Adjust the AC Calibrator output to zero.

6. Connect the DMM red and yellow leads to the AC Calibrator OUTPUT HI connector and the black, green, and blue leads to the OUTPUT LO connector.

7. Adjust the AC Calibrator frequency to 35 kHz and voltage to 100.000V. Depress the DMM REFERENCE EXT 100 switch. Observe a DMM readout of 1.00000 ± 100 digits.

8. Adjust the AC Calibrator frequency to 100 kHz and voltage to 10.0000V. Depress the DMM REFERENCE EXT 10 switch. Observe a DMM readout of 1.00000 ± 130 digits.

9. Adjust the AC Calibrator voltage to 1.00000V. Observe a DMM readout of 1.00000 ± 130 digits. Disconnect the test setup.

AC/DC Ratio Measurement

To verify the AC/DC ratio accuracy:

1. Connect the signal input leads together. Position the front panel switches to the initial position (table 3-2).

2. Repeatedly depress the FUNCTION STEP switch until the AC function indicator lights. Depress the FUNCTION INT LOK switch.

3. Refer to figure 4-3. Connect the DMM red lead to the AC Calibrator OUTPUT HI terminal and the black and green leads to the OUTPUT LO terminal.

CAUTION

Do not exceed 10 VDC reference input. Failure to observe this caution may damage the Reference Amplifier Assembly.

4. Connect the DMM yellow and blue leads to the DC Voltage Calibrator with the yellow lead to the positive terminal. Adjust the DC Voltage Calibrator output to 10.0000V.

NOTE

If the optional DC Reference Voltage Attenuator is installed, do not perform steps 5 and 6. Perform steps 7 and 8.

5. Depress the REFERENCE EXT 10 and REFERENCE EXT DC switches.

CAUTION

Do not exceed 10 VDC reference input. Failure to observe this caution may damage the Reference Amplifier Assembly.

6. Adjust the AC Calibrator output voltage to 10.0000V and to the following frequencies and observe the indicated DMM readout:

   a. 1 kHz. Observe 1.00000 ± 103 digits.

   b. 35 kHz. Observe 1.00000 ± 206 digits.

   c. 100 kHz. Observe 1.00000 ± 456 digits.

CAUTION

Do not exceed 100 VDC reference input. Failure to observe this caution will damage the Reference Amplifier Assembly.

7. Adjust the DC Voltage Calibrator output to 100.000V. Depress the REFERENCE EXT 100 and REFERENCE EXT DC switches.

8. Adjust the AC Voltage Calibrator output voltage to 100.000V and to the following frequencies and observe the indicated DMM front panel readouts:

   a. 1 kHz. Observe 1.00000 ± 103 digits.

   b. 35 kHz. Observe 1.00000 ± 206 digits.

   c. 100 kHz. Observe 1.00000 ± 456 digits.

9. Reduce the two voltage source outputs to zero and disconnect the test setup.

DC/AC Ratio Measurement

To verify the DC/AC ratio measurement:

1. Connect the signal input leads together. Position the front panel switches to the initial position (table 3-2).

2. Repeatedly depress the FUNCTION STEP switch until the DC function indicator lights. Depress the FUNCTION INT LOK switch.

3. Connect the DMM red lead to the DC Voltage Calibrator positive terminal and the black and green leads to the negative terminal. Adjust the DC Voltage Calibrator output voltage to 1000.00V.

CAUTION

Between 50 Hz and 20 kHz do not apply more than 1000V rms to the DMM. Between 20 kHz and 50 kHz do not apply more than 500V rms. Between 50 kHz and 100 kHz do not apply more than 250V rms. Failure to observe this caution may result in damage to the instrument.

4. Connect the DMM yellow and blue leads to the High Voltage Amp with the yellow lead to the high output terminal.

5. Adjust the AC Voltage Calibrator output frequency to 1 kHz and output voltage to 1000.00V. Depress the REFERENCE EXT 1K and REFERENCE EXT AC switches. Observe a DMM readout of 1.00000 ± 113 digits.

6. Adjust the AC Voltage Calibrator output voltage to zero. Disconnect the yellow and blue leads from the High Voltage Amp and connect the leads to the AC Voltage Calibrator with the yellow lead to the OUTPUT HI terminal and the blue lead to the OUTPUT LO terminal.

7. Adjust the AC Voltage Calibrator output frequency to 35 kHz and output voltage to 100.000V. Depress the REFERENCE EXT 100 switch.

8. Adjust the DC Voltage Calibrator output voltage to 100.000V. Observe a DMM readout of 1.00000 ± 238 digits.

9. Adjust the AC Voltage Calibrator output frequency to 100 kHz and output voltage to 10.0000V. Depress the REFERENCE EXT 10 switch.

10. Adjust the DC Voltage Calibrator output voltage to 10.0000V. Observe a DMM readout of 1.00000 ± 510 digits.

11. Adjust the output of the two voltage sources to zero and disconnect the test setup.

INPUT RESISTANCE

Input resistance verification is accomplished by measuring the input current and calculating the resistance. The input resistance is expressed in ohms using the following formulas (see figure 4-5):

$$\text{Input Current} = \frac{\text{DMM Readout With S1 Closed} - \text{DMM Readout With S1 Opened}}{\text{Series Resistance}}$$

$$\text{Input Resistance} = \frac{\text{DMM Readout With S1 Open}}{\text{Input Current}}$$

NOTE

Input shielding may be necessary in a noisy environment.

DC Signal Input Resistance

To verify the DC signal input resistance:

1. Connect the signal input leads together. Position the front panel switches to the initial setting (table 3-2).

2. Repeatedly depress the FUNCTION STEP switch until the DC function indicator lights. Depress the FUNCTION INT LOK and FILTER FULL switches.

3. Connect the test setup as shown in figure 4-5.

4. Close S1 and adjust the test setup for a DMM front panel readout of 10.0000V.

5. Open S1 and observe that the DMM readout decreases by 0.01% (0.0010V) or less.

6. A decrease of less than 0.0010V represents an input resistance in excess of 10,000 megohms.

7. Disconnect the test setup.

AC Signal Input Impedance

To verify the AC signal input impedance:

1. Connect the signal input leads together. Position the front panel switches to the initial setting (table 3-2).

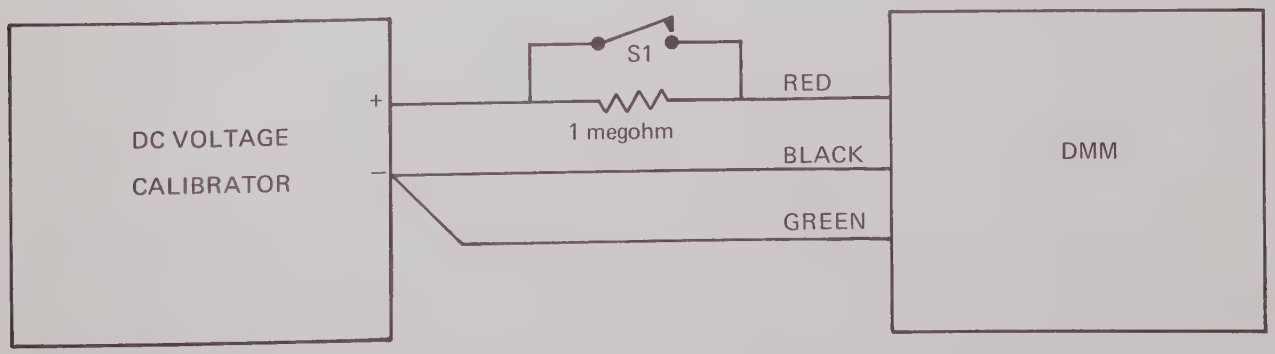


Figure 4-5. Input Resistance Test Setup.

2. Repeatedly depress the FUNCTION STEP switch until the AC function indicator lights. Depress the FUNCTION INT LOK switch. Momentarily depress the RANGE UP switch.

3. Refer to figure 4-3. Connect a 100 kΩ ± 0.1% resistor in series between the DMM red lead and the AC Voltage Calibrator OUTPUT HI terminal. Connect the DMM black and green leads to the OUTPUT LO terminal.

4. Adjust the AC Voltage Calibrator output frequency to 100 Hz and output voltage to 10.0000V.

5. Observe that the DMM readout is less than the applied voltage by no more than 10%, indicating an input impedance of at least 1 MΩ.

6. Disconnect the test setup.

COMMON MODE REJECTION

The following procedure is used for both AC and DC common mode rejection verification. The AC common mode voltage source is 60 Hz from an AC voltage calibrator. The DC common mode voltage source is a DC voltage calibrator. If the common mode voltage is E_{cm} and the least significant digit change of the front panel indication is defined as the error voltage E_e, the common mode voltage rejection ratio is expressed in decibels by the following formula:

$$\text{Common Mode Rejection} = 20 \log \frac{E_{cm}}{E_e}$$

To verify the common mode rejection:

1. Measure the resistance between signal low (black input lead) and power line ground (terminal E6), The measurement must indicate infinity. Correct any short or leakage before proceeding.

2. Position the front panel switches to the initial setting (table 3-2). Repeatedly depress the FUNCTION STEP switch until the DC function indicator lights. Depress the FUNCTION INT LOK and FILTER MED switches. Momentarily depress the RANGE UP switch.

3. Connect the test setup shown in figure 4-6, using the DC Voltage Calibrator as the common mode source. Adjust the common mode source output to zero.

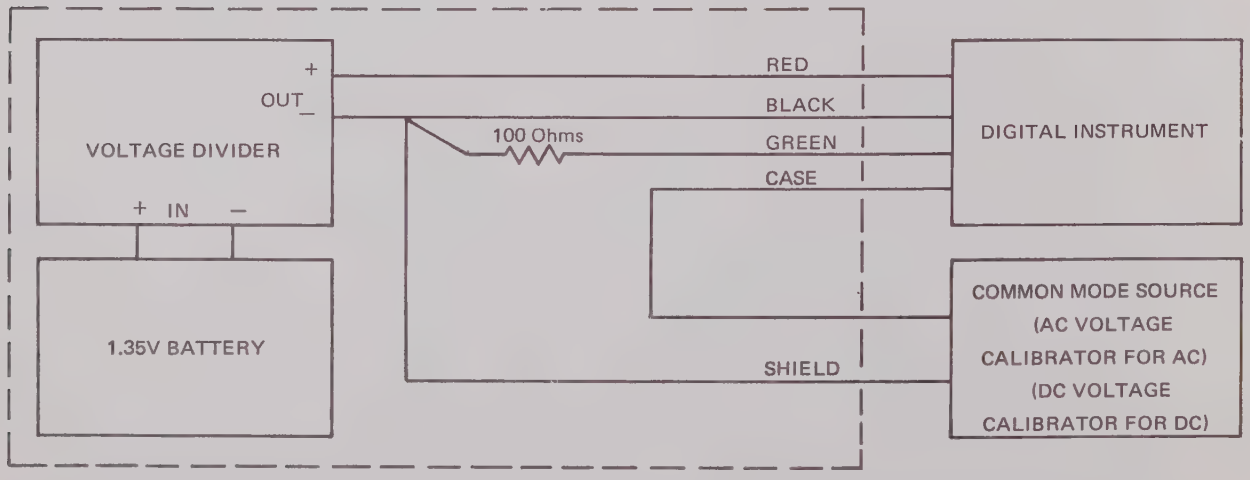


Figure 4-6. Common Mode Rejection Test Setup.

4. Adjust the voltage divider for a DMM readout of 1.0000.

5. Adjust the common mode source output to 1000V. Observe that the DMM readout is stable at 1.0000, indicating a common mode rejection of 140 dB.

6. Adjust the common mode source output to zero. Momentarily depress the RANGE UP switch. Depress the FUNCTION MV/DC switch.

7. Adjust the voltage divider for a DMM readout of 100.000.

8. Adjust the common mode source output to 30V. Observe that the DMM readout is stable at 100.000 ± 3 digits, indicating a common mode rejection of 140 dB.

9. Adjust the common mode source output to zero. Momentarily depress the DMM RANGE DN switch. Adjust the voltage divider for a DMM readout of 10.0000.

10. Adjust the common mode source output to 30V. Observe that the DMM readout is stable at 10.0000 ± 10 digits, indicating a common mode rejection of 150 dB.

11. Adjust the common mode source output to zero and disconnect from the test setup.

12. Repeatedly depress the FUNCTION STEP switch until the MV function indicator is extinguished and the DC function indicator is lighted. Depress the FUNCTION INT LOK and FILTER FULL switches. Momentarily depress the RANGE UP switch.

13. Adjust the AC Voltage Calibrator output to zero and connect to the test setup (figure 4-6).

14. Adjust the voltage divider for a DMM readout of 1.0000.

15. Adjust the common mode source output to 100 VAC peak-to-peak (35.3 VAC rms) 60 Hz.

16. Adjust the voltage divider to stabilize the DMM readout and observe that the readout is stable at 1.0000, indicating a common mode rejection of 120 dB.

17. Adjust the common mode source output to zero.

18. Depress the FUNCTION MV/DC and FILTER FULL switches. Momentarily depress the RANGE UP switch. Adjust the voltage divider for a DMM readout of 100.000.

19. Adjust the common mode source output to 3.2 VAC peak-to-peak (1.13 VAC rms) 60 Hz.

20. Adjust the voltage divider to stabilize the DMM readout and observe that the readout is stable at 100.000, indicating a common mode rejection of 130 dB.

21. Adjust the common mode source output to zero.

22. Momentarily depress the RANGE DN switch. Adjust the voltage divider for a DMM readout of 10.0000.

23. Adjust the common mode source output to 1 VAC peak-to-peak (0.3535 VAC rms) 60 Hz.

24. Adjust the voltage divider to stabilize the DMM readout and observe that the readout is stable at 10.0000, indicating a common mode rejection of 140 dB.

25. Adjust the common mode source output to zero and disconnect from the test setup.

NORMAL MODE REJECTION

If the normal mode voltage is E_{nm} and the least significant digit change of the front panel indication is

defined as the error voltage E_e, the normal mode voltage rejection ratio is expressed in decibels by the following formula:

$$\text{Normal Mode Rejection} = 20 \log \frac{E_{nm}}{E_e}$$

To verify the normal mode rejection:

1. Position the front panel switches to the initial setting (table 3-2).
2. Repeatedly depress the FUNCTION STEP switch until the DC function indicator lights. Depress the FUNCTION INT LOK and FILTER FULL switches. Momentarily depress the RANGE UP switch.
3. Connect the test setup shown in figure 4-7. Adjust the AC Voltage Calibrator output to zero.
4. Adjust the voltage divider for a DMM readout of 1.0000.
5. Adjust the AC source output to 3.53 VAC peak-to-peak (1.247 VAC rms), 60 Hz.
6. Adjust the voltage divider to stabilize the DMM readout and observe that the readout is stable at 1.0000, indicating a normal mode rejection of 90 dB.
7. Adjust the AC source output to zero.
8. Depress the FILTER MED switch.
9. Adjust the voltage divider for a DMM readout of 1.0000.
10. Adjust the AC source output to 0.01 VAC peak-to-peak (0.0035 VAC rms) 60 Hz.
11. Adjust the voltage divider to stabilize the DMM readout and observe that the readout is stable at 1.0000, indicating a normal mode rejection of 40 dB.
12. Adjust the AC source output to zero.
13. Adjust the voltage divider for a DMM readout of 1.0000.
14. Adjust the AC source output to 1 VAC peak-to-peak (0.3535 VAC rms), 400 Hz.
15. Adjust the voltage divider to stabilize the DMM indication and observe that the indication is stable at 1.0000, indicating a normal mode rejection of 75 dB.
16. Disconnect the test setup.

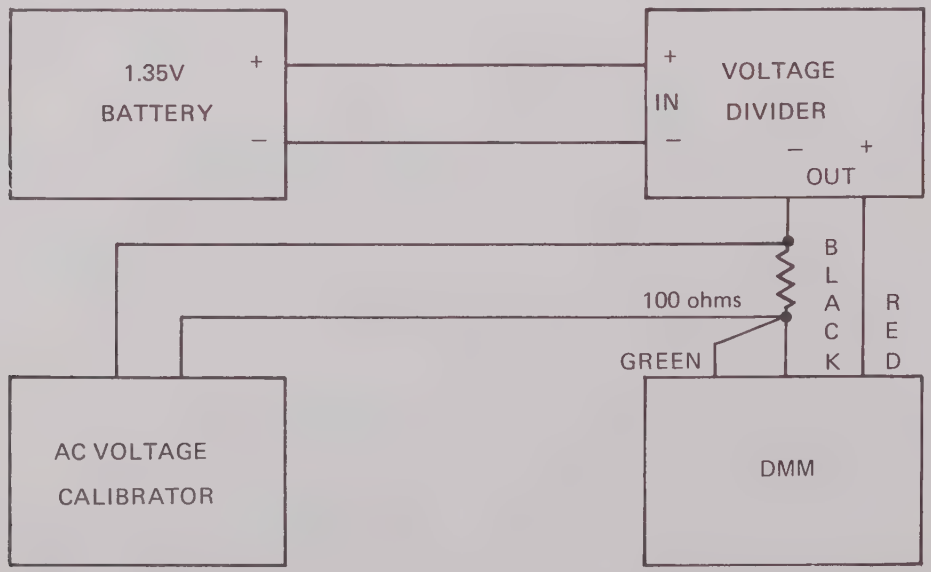


Figure 4-7. Normal Mode Rejection Test Setup.

SECTION V
THEORY OF OPERATION

In the following discussion it is assumed that all optional accessories are included in the instrument.

GENERAL DESCRIPTION

BASIC INSTRUMENT

DC Measurement Mode

The basic instrument is essentially a closed loop servo system (figure 5-1). A stable, internally-generated reference voltage is connected across a precision resistance ladder comprised of a series of narrow-tolerance resistors. Instrument logic drives the resistance ladder until the sum of the incremental voltage steps equals the unknown input signal value. The front panel indicators display the incremental changes of the precision voltage as they are provided by the resistance ladder. When a state of balance between the sum of the precision voltage incremental changes and the unknown voltage value is attained, a null condition exists. The value displayed by the front panel indicators represents the unknown voltage value.

Resistance ladder drive is accomplished by the servo system activated by the difference sensed in a voltage comparison circuit. Voltage comparison is accomplished by a solid state comparator which compares the unknown voltage and the Digital to Analog Converter (DAC) resistance ladder output. The comparator produces a logic level output state that indicates the polarity of the error voltage. The logic level signal is applied to the up and down logic drivers. The driver signals the control logic which direction the triquinary counter should count to produce a null condition. As the counter changes, the output of the DAC changes until a null condition is achieved. At this time the front panel indicators, which monitor the state of the triquinary counter decades, indicate the decimal equivalent of the unknown input voltage.

DC/DC Automatic Bipolar Ratio Mode

In the DC/DC automatic bipolar ratio mode, the instrument compares an unknown DC input signal voltage with a known external DC reference voltage. The internal reference voltage is disconnected. The

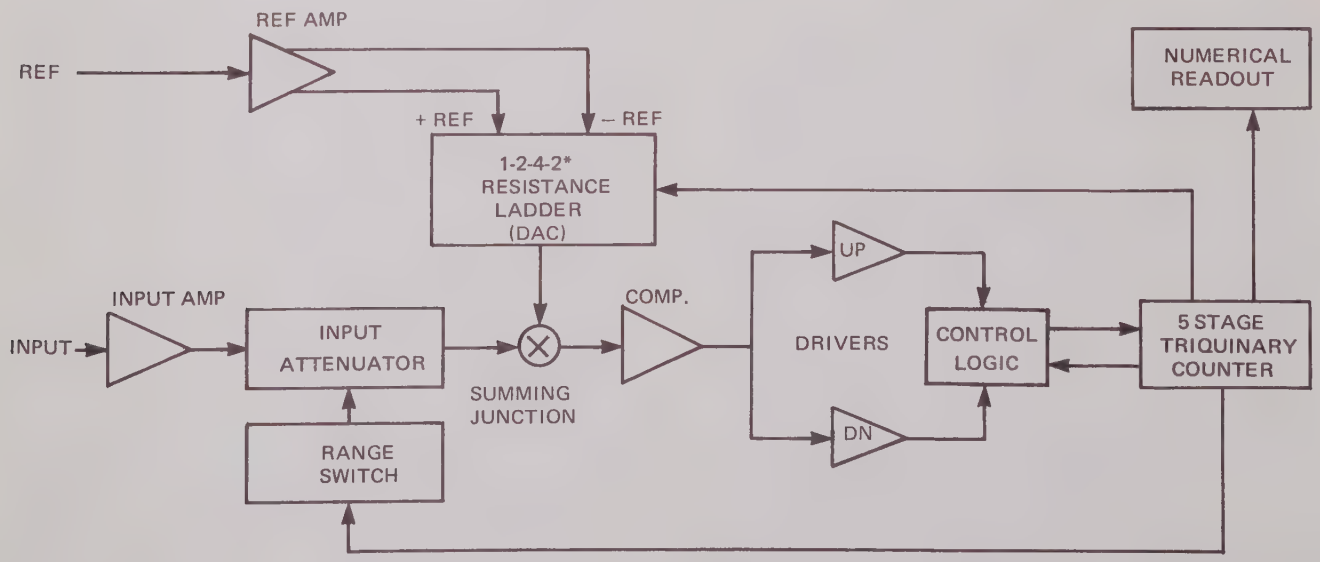


Figure 5-1. Simplified Block Diagram of Closed Loop Servo System.

external reference voltage, which may be either polarity and vary between 0.1V and 100V DC, is connected to the resistance ladder through the reference amplifiers. A null is achieved in the same manner as in the DC measurement mode. The decimal point position indicates the arithmetical value of the ratio. The automatic bipolar circuit automatically computes the algebraic sum of the signs of both the signal and reference inputs. This sum is displayed as the polarity sign of the ratio.

AC Converter

The AC converter converts a full scale input voltage of 1V to 1000V to a DC voltage that is proportional to the average value of the input AC signal. The converter is calibrated so that the correct rms value of a sine wave is displayed on the readout.

AC/AC Ratio Mode

In the AC/AC ratio mode both the unknown AC input signal and the known AC reference input are connected to AC converters where they are converted to DC voltages. The ratio of these two voltages is then determined the same as in the DC/DC ratio mode. The ratio is in "real time" with no phase shift errors when using two AC Converters. In AC/AC ratio the polarity readout is blanked out.

AC/DC Ratio Mode

In the AC/DC ratio mode an unknown AC input signal of from 1 to 1000 volts is compared with a known DC reference voltage. The AC input signal is converted to a DC voltage by an AC converter. Operation is then the same as in the DC/DC ratio mode. When in AC/DC ratio mode the polarity readout is blanked out.

DC/AC Ratio Mode

In the DC/AC ratio mode an unknown DC input signal is compared with a known AC reference input. The AC reference input is converted to a DC reference voltage by the AC reference converter. Operation is then the same as for DC/DC ratio. In DC/AC ratio the polarity sign indicates the polarity of the unknown DC input signal.

HIΩ-MV Converter

The millivolt section of the HIΩ-MV Converter amplifies a millivolt input signal by a factor of 100 or 1000, depending upon range.

The ohms converter supplies a precision current value through an unknown resistance; this develops a voltage proportional to the value of the resistance. Two-and four-wire measurement techniques are employed for measuring resistance. The DC output voltage of the HIΩ-MV Converter is 10.9999 volts full scale. The outputs are measured by the basic instrument and indicated on the readout as MV or KΩ values.

Low Ohms Converter

The low ohms converter has a floating reference which supplies a precision current value to an unknown resistance, this develops a voltage proportional to the value of resistance. The voltage is sensed by the HIΩ-MV converter whose output is then measured by the basic instrument and displayed as an ohms value. Errors due to lead resistance are minimized by using four-wire sensing.

100 MΩ Range

The 100 MΩ Range Assembly supplies a precision current value to an unknown resistance, this develops a voltage proportional to the value of the resistance. The DC output voltage is measured by the basic instrument and displayed as a MΩ value. The use of a FET amplifier ensures that errors due to leakage are minimized.

BLOCK DIAGRAM AND COUNTING LOGIC DESCRIPTION

Diagram 1 in Section VI is a block diagram of the Digital Multimeter (DMM). The Power Supply, Print Output, and Input Buffer Assemblies, together with some of the logic and control paths, have been omitted. Units shown within heavy lines are mounted on the same assembly board. The DMM resistance ladder, and associated drive circuitry, is comprised of the five Decoders and the Polarity switch.

When the DMM is in the voltage or ratio measurement mode, the input signal is applied to the Input Selector Assembly and routed directly to the Input Attenuator. In DC/DC ratio measurement mode, an external ±1 to ±100 reference voltage is applied to the Input Selector Assembly and routed through the Comparator Assembly to the Reference Amplifiers.

In the AC/AC and DC/AC ratio mode, an external AC reference voltage is applied to the Input Selector Assembly and routed to the reference AC Converter Assembly. From the reference AC Converter the proportional DC voltage is applied to the Reference Amplifier.

In the AC/AC and AC/DC ratio mode the AC input signal is routed through the Input Selector Assembly to the signal AC Converter Assembly where it is converted to 1.09999 volts DC full scale.

In the AC voltage measurement mode, the AC input signal is routed through the Input Selector Assembly to the signal AC Converter Assembly. There it is converted to 1.09999 volts DC full scale.

In the MV or KΩ measurement mode, the input signal is routed through the Input Selector Assembly to the HIΩ-MV Converter Assembly where it is converted to 10.9999 volts DC full scale.

In the LOΩ measurement mode the input signal is routed through the Input Selector Assembly to the LOΩ Converter Assembly. There it is converted to 10.9999 millivolts DC full scale for the 1Ω range and 100 MV for all other ranges.

In the 100 MΩ measurement mode the input signal is routed through the Input Selector Assembly to the 100 MΩ Converter Assembly. There it is converted to 10.9999 volts DC full scale.

The outputs of the AC, LOΩ, 100 MΩ, and HIΩ-MV Converters are routed through the Input Selector Assembly, and an active filter directly to the Input Amplifier. The Input Attenuator is by-passed.

When autoranging in the voltage or ratio measurement mode, the input signal amplitude is between 11 and 109.999 volts. The signal is attenuated by a factor of 10 to 1 by the Input Attenuator. When the input signal amplitude is between 110.00 and 1099.99 it is attenuated by a factor of 100 to 1. The degree of attenuation is controlled by signals from the Function Decimal Assembly.

The Input Amplifier is a high gain, field effect transistor input, operational amplifier. It is connected potentiometrically for maximum input impedance. In the 1-volt range, the gain is 10 and in the 10, 100, 1K and 10K ranges, the gain is 1. The gain is controlled by signals from the Function Decimal Assembly.

When the DMM front panel FILTER FUNCTION switches are not depressed, the output of the Input Buffer Amplifier is applied to the Inverting Amplifier input with no filtering.

Both the Medium Filter and Full Filter are a combination of passive and active filters. When the FILTER MED switch is depressed, the Medium Filter is activated. When the FILTER FULL switch is depressed, both the Medium and Full Filters are activated. The Filters are controlled by signals from the Function Decimal Assembly.

The Inverting Amplifier is a unity gain operational amplifier that isolates the Input Amplifier and Filters from the Summing Junction.

The output currents of the Input Amplifier Assembly and the Resistance Ladder are summed at the Summing Junction and applied to the Comparator Amplifier.

The Comparator Amplifier has an output of zero volts when the instrument is in a null condition. If the Summing Junction output changes the current equivalent of 100 microvolts in a positive direction, the Comparator Amplifier output changes 0.3 volt in a negative direction. Conversely, when the Summing Junction output swings negative the Comparator Amplifier output goes positive. The output of the Comparator Amplifier is applied to the Positive and Negative Comparators.

The Positive Comparator input is biased at +0.3 volt. When the input is less positive than +0.3 volt, the Positive Comparator output is –0.3 volt. When the input becomes greater than +0.3 volt, the Comparator output changes to +3 volts.

Operation of the Negative Comparator is similar to the Positive Comparator, except that the input is biased at –0.3 volt. When the input is less negative than –0.3 volt, the output is –0.3 volt. When the input becomes greater than –0.3 volt, the output changes to +3 volts.

Instrument sensitivity is controlled by signals applied to the assembly from the Function Decimal Assembly. The outputs of the Comparators are applied to the Control Logic.

The Control Logic performs the following functions:

1. Generates clock pulses that synchronize Decade and Autorange operations.

2. Utilizes pulses received from the Positive and Negative Comparators to develop up drive and down drive pulses and applies the pulses to the Units Decade and the Print Control Assembly.

3. Controls:

   a. The DMM front panel polarity indication.

   b. Polarity of output signals from the Decades to the Decoders.

   c. Operation of the Polarity Switch.

4. Enables control of the signal tracking repetitive mode of operation.

The clock output is a pulse of 40 microseconds width generated at a 4 kilohertz rate. The output is applied to the Decades and Autorange Assembly to synchronize circuit operation with receipt of up and down drive pulses and up and down range pulses, respectively.

When the Polarity Switch is in the positive polarity configuration and the Negative Comparator pulses, the Control Logic generates an up drive pulse to the Units Decade and the Print Control Assembly. If the Positive Comparator had pulsed instead, the Control Logic would have generated a down drive pulse. When the Polarity Switch is in the negative polarity configuration and the Negative Comparator pulses, a down drive pulse is generated. In the negative polarity configuration, if the Positive Comparator had pulsed an up drive pulse would have been generated.

The Control Logic changes the DMM polarity configuration when the front panel numerical readout is all zeros and a down drive pulse is generated.

The DMM can be changed from constant tracking to repetitive tracking when the front panel REPETITIVE MODE switch/potentiometer is turned on. The switch/potentiometer also enables control of the repetitive mode tracking rate. In the repetitive mode, the Control Logic tracks the input signal for 60 milliseconds and then:

1. Locks out signals from the Positive and Negative Comparator until another repetitive-mode-start pulse is generated.

2. Applies a Repetitive-Mode-Print pulse to the Print Control Assembly that, if the front panel PRINT AUTO switch is depressed, forces a printout.

The Decades generate 1-2-4-8 BCD positive polarity information to the Display Driver Assembly and Print Output Assembly (not shown) and 1-2-4-2* BCD information to the Decoders. The latter information may be either positive or negative, dependent on the DMM polarity configuration.

The Decades use triquinary logic to minimize tracking time. When receiving up drive pulses, the Decades, except the Ten Thousands Decade, count up 1-3-5-7-9-up transfer. The Ten Thousands Decade counts 1-3-5-7-9-10-up range. When receiving down drive pulses, the Decades, except the Ten Thousands Decade, count down from an odd-numbered state to the next lower even-numbered state, then directly to zero and then on the next down drive pulse, down transfer. When the Ten Thousands Decade is in a 10-state, it counts down 9-8-1-0-polarity change. When in any state other than 10, it counts down from an odd-numbered state to the next even-numbered state and then to 1. The next two down drive pulses cause it to count to zero and then to polarity change.

To illustrate the counting logic: assume that the input signal increases from zero to 0.0190 volt and then decreases to zero (table 5-1). A series of up drive pulses

cause the Units Decade to count 1-3-5-7-9. On the next up drive pulse, the Units Decade generates a units-up-transfer (UUT) pulse. The Units Decade remains in a 9 state. The UUT pulse and succeeding UUT pulses cause the Tens Decade to count 1-3-5-7-9 and then generate a tens-up-transfer (TUT) pulse. The Tens Decade remains in a 9 state. The TUT pulse causes the Hundreds Decade to count to 1. The front panel numeral indication is now 0.0199, which is higher than the value of the input signal. The DMM logic then generates two down drive pulses. The first pulse causes the Units Decade to count to 8, and the second pulse to count to zero. The front panel indication is now 0.0190, which is correct. When the input signal decreases to zero, a series of down drive pulses are generated. The Units Decade is already at zero, so the first down drive pulse causes the Decade to generate a units-down-transfer (UDT) pulse. The UDT pulse sets the Tens Decade to 8. The next down drive pulse and resultant UDT pulse cause the Tens Decade to count to zero. The third down drive and UDT pulse cause the Tens Decade to generate a tens-down-transfer (TDT) pulse which in turn sets the Hundreds Decade to zero. The front panel indication is now 0.0000.

Assume that the input signal is 10.9999 volts. When all the Decades have counted up to 9, the next up drive pulse sets the Ten Thousands Decade to 10. The other Decades remain in the 9 state. The front panel indication is 10.9999. The DMM is now in overrange. A numeral 1 appears in the overrange window of the front panel indication whenever the Ten Thousands Decade is in the 10 state.

Assume that the DMM is in AUTO RANGE and that the input signal voltage increases from 10.9999 to 11.000 volts. An up drive pulse causes the Ten Thousands Decade to generate a Ten Thousands Up (TKUP) pulse that causes the Autorange Assembly to shift to the next higher range. The DMM logic then generates a series of:

1. Down drive pulses that sets the Ten Thousands Decade to 1 and the other Decades to zero.

2. Up drive pulses that set the Units, Tens, and Hundreds Decades to 9 and the Thousands Decade to 1.

Table 5-1. Typical Logic Counting Sequence.

DRIVE PULSE	DECADE STATES				
	10K	1K	100	10	1
	0	0	0	0	0
UP	0	0	0	0	1
UP	0	0	0	0	3
UP	0	0	0	0	5
UP	0	0	0	0	7
UP	0	0	0	0	9
UP (UUT)	0	0	0	1	9
UP (UUT)	0	0	0	3	9
UP (UUT)	0	0	0	5	9
UP (UUT)	0	0	0	7	9
UP (UUT)	0	0	0	9	9
UP (TUT)	0	0	1	9	9
DN	0	0	1	9	8
DN	0	0	1	9	0
DN (UDT)	0	0	1	8	0
DN (UDT)	0	0	1	0	0
DN (TDT)	0	0	0	0	0

3. Down drive pulses that set the Units, Tens and Hundreds Decades to zero. The front panel indication is now 11.000.

If the DMM was in the 10-volt manual range instead of AUTO RANGE when the input signal increased from 10.9999 to 11.000 volts, the front panel indication would remain 10.9999. The TKUP pulse from the Ten Thousands Decade would be applied to the Display Driver and cause the overrange 1 to slowly and continuously blink, indicating the reading is in error.

If the input signal decreases from 11.000 to 9.9999 volts, the DMM logic generates a series of down drive pulses that successively set all the Decades to zero. The Ten Thousands Decade is now in a Not Ten Thousands Zero ($\overline{\text{TK0}}$) state that causes the Autorange Assembly to shift to the next lower range on the next clock pulse.

At this point, a polarity change is prevented by the Control Logic. The logic then generates up drive pulses until all the Decades are in a 9 state.

If the input signal changes from a positive to a negative polarity, the logic generates down drive pulses that set all the Decades to zero. The next down drive pulse causes the Thousands Decade to generate a thousands-down-transfer (KDT) pulse and the Ten Thousands Decade to generate a $\overline{TK0}$ state. The two pulses are applied to the Control Logic and indicate that all Decades are in a zero state. The Control Logic reverses the – and + polarity outputs and the DMM is in a negative polarity configuration.

The Decade counting sequence is so rapid that when watching the front panel indication the change appears to be nearly instantaneous.

The reference section of the comparator contains a voltage reference that supplies 10 volts to the reference amplifier. The reference amplifier amplifies the voltage by a factor of 1.1. There are two amplifiers. When the DMM is in any measurement mode other than RATIO, the Reference Amplifiers furnish the internally generated 10 volts as a +11 and –11 reference voltage to the Decoder Assemblies and Polarity Switch. In the RATIO mode the voltage reference module is disconnected from the amplifier and an external DC reference voltage is substituted. The external voltage amplitude can be from ±0.1V to ±100 volts.

Figure 5-2 is a simplified presentation showing the operating principles of the Decoders.

When the DMM is in the positive polarity configuration, the numbered switches are connected to the –11 reference voltage and the POLARITY switch to the +11 reference voltage. The numbered switches tend to drive the Summing Junction negative. The POLARITY switch resistor of 36.36 kilohms equals the parallel combination of the four numbered switch resistors, the O/R switch resistor, and the 400 kilohm terminating resistor. The +11 volts applied to the POLARITY switch resistor offsets the –11 volts applied through the numbered switch resistors and the Summing Junction is held at zero. If the associated Decade driving the Decoder sets a 1, the 400-kilohm resistor will be switched to +11 volts and the Summing Junction output will move positive the current equivalent of 1 volt. When the Control Logic causes the DMM polarity configuration to change, the – and + polarity outputs of the Control Logic are reversed. The POLARITY switch, figure 5-2, is now connected to –11 volts and the numbered switches to +11 volts. Again the output of the Decoder is zero. When a 1 is now set, the 400-kilohm resistor is switched to –11 volts and the Summing Junction is driven negative.

The Autorange Assembly contains the four-state function counter and the six-state range counter. When the front panel RANGE AUTO switch is depressed the instrument automatically up-ranges when the input exceeds 109999, and down-ranges when the input falls

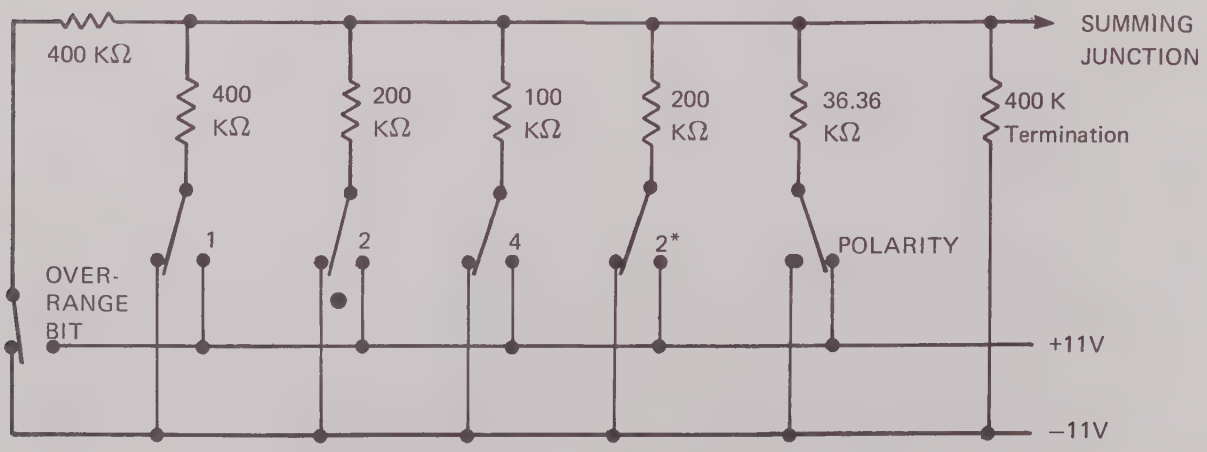


Figure 5-2. Simplified Decoder.

below 100000. The RANGE DN and RANGE UP switches allow manual range setting to any range.

The function counter is stepped by pressing the FUNCTION STEP switch. The front panel indicator lamps indicate which function is programmed. Pressing the function LOK switch then connects the input leads to the Input Selector Assembly. When the FUNCTION MV/DC switch is depressed the instrument will autorange between the 10 MV range and the 1KV range. When autoranging from the 10 MV range the maximum step input voltage that can safely be applied is 200 volts. The range and function output information from the Autorange Assembly is then applied to all assemblies requiring range and function information.

The Function Decimal Assembly decodes range information from the Autorange counter and function information from the FUNCTION counter. The information enables the assembly to:

1. Illuminate the appropriate decimal indicator on the Display Assembly.

2. Control attenuation relays on the Input Attenuator.

3. Control the gain of the Input Amplifier.

Dependent upon the positions of the front panel FILTER and SENSITIVITY switches, the assembly also selects the degree of input signal filtering and DMM sensitivity.

The Display Driver Assembly receives 1-2-4-8 BCD information from the Decades. Each Decade supplies information to an associated numeral readout tube, i.e., Units Decade to units readout tube and Tens Decade to tens readout tube. The Ten Thousands Decade supplies both the ten thousands and the overrange readout tubes. The BCD information is decoded to 10-line decimal code and used to illuminate the numeral readout tubes. Decimal information received from the Range and Decimal Decoder Assembly illuminates the appropriate decimal indicator. The polarity indicators are illuminated by the – and + polarity outputs of the Control Logic.

When the DMM is in the AUTO PRINT mode, with the REPETITIVE mode switch off and with no signal input filtering, the Print Control Assembly issues a print command to the Print Output Assemblies when no up drive or down drive pulses are received from the Control Logic for 15 milliseconds, a null condition. Another print command will not be issued until the value of the input signal changes and another null is attained. From the time the Print Control detects a null and issues a print command until the time a Ready signal is generated, the Print Control applies a Print Clamp command to the Control Logic. The Print Clamp command locks out further up and down pulses from the Positive and Negative Comparators to the Control Logic.

In remote control, if the voltage being measured has an AC component and the Print Control Assembly cannot detect a null at the input of the Units Decade within 45 milliseconds, the assembly will, when programmed:

1. Desensitize itself and scan the Tens Decade for a null.

2. After 45 milliseconds of scanning the Tens Decade without detecting a null, further desensitize itself and scan the Hundred Decade input.

3. If, in an extreme condition, a null still cannot be detected after scanning the Hundreds Decade for 45 milliseconds, issue a Print command to the Print Output Assemblies.

When a printout is made, the printout information indicates whether or not desensitization has occurred. If desensitization has occurred, the degree is indicated.

In the repetitive tracking mode, the Print Control Assembly issues a Print Command each time it is so directed by the Control Logic.

A power supply (not shown in diagram 1) is mounted outside of the guard shield on the Print Control Assembly. The power supply furnishes voltage to voltage-state print output assemblies, to the relay coils of remote buffer assemblies, and to the buffered print output assemblies as reference voltage.

INSTRUMENT SENSITIVITY

Instrument sensitivity is defined as the minimum input signal that will cause a one-digit change in the units window of the front panel numerical indication.

The sensitivity of the Model 6853 is determined by the gain of the Comparator Amplifier Assembly. Figure 5-3 is a simplified schematic diagram of the Comparator Amplifier. Switches X2, 4, and 16 control the amplifier gain.

The nominal gain of COMP AMP 1 is 30 and COMP AMP 2, 100. The overall gain is 3000. With switches X2, 4, and 16 open, a 100-microvolt input signal will result in a 0.3-volt output signal. A nominal value of 0.3 volt is required to drive the positive and negative comparators which in turn drive the control logic. The DMM therefore has a sensitivity of 100 microvolts.

When switch X2 is closed the COMP AMP 1 feedback is doubled and the gain of COMP AMP 1 is reduced to 15. It would then require an input signal of 200 microvolts to maintain the 0.3 volt output of COMP AMP 2.

When switch X2 is open and switch 4 is closed, the gain of COMP AMP 2 is reduced to 25 and the overall gain to 750. An input signal of 400 microvolts is now required to produce a 0.3-volt output. If, while switch 4 was closed, switch X2 was also closed the sensitivity would be 800 microvolts.

Switches X2, 4, and 16 are front panel mounted SENSITIVITY switches. Switches 4 and 16 are interlocked and cannot be closed simultaneously. Therefore DMM sensitivity cannot be reduced below 3200 microvolts by means of the switches.

INSTRUMENT SETTLING TIME

The settling time of the DMM, when there is no range change, is determined primarily by the amplitude of a signal input step change and the recovery time of the amplifiers and filters on the Input Amplifier Assembly, and to a lesser extent by the DMM logic counting time. The amplifiers must have time to respond to the step change and the assembly filters time to charge and discharge.

Figure 5-4 shows a "worst case" settling time for a step change within a single range. Assume that the DMM is in the 10-volt range and the input voltage steps from 0 to 8.8888 volts. The 8.8888 step is chosen because it represents the maximum logic upcounting time.

When the DMM is in the 100-volt range and the step change is 88.888 or in the 1000-volt range and the step

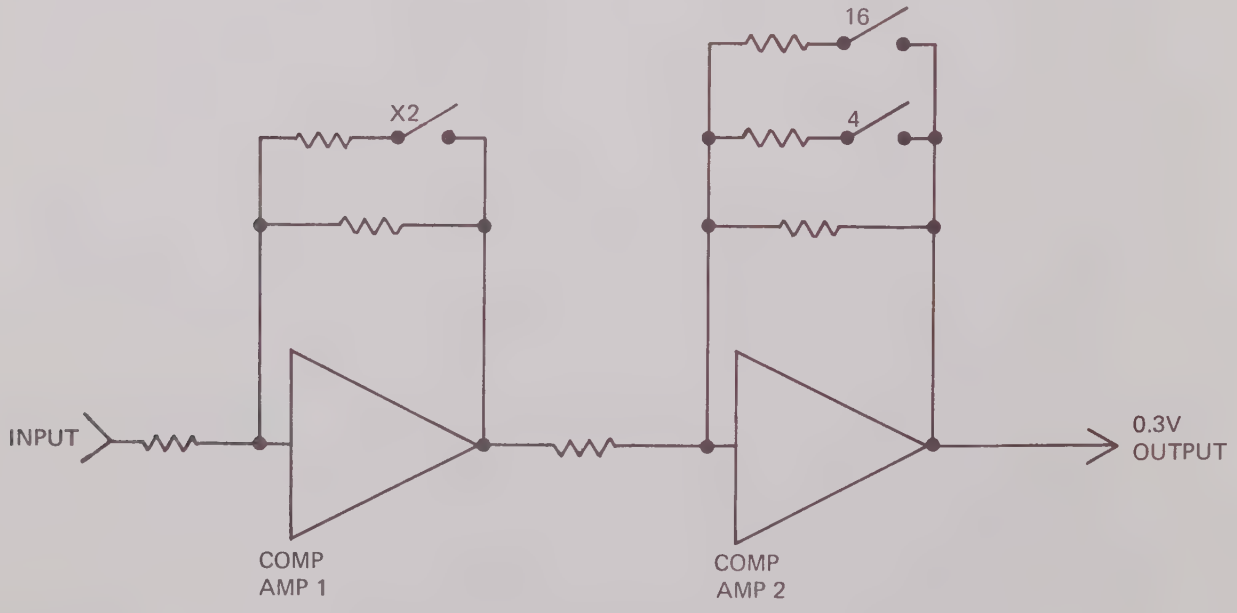


Figure 5-3. Comparator Amplifier Simplified Schematic Diagram.

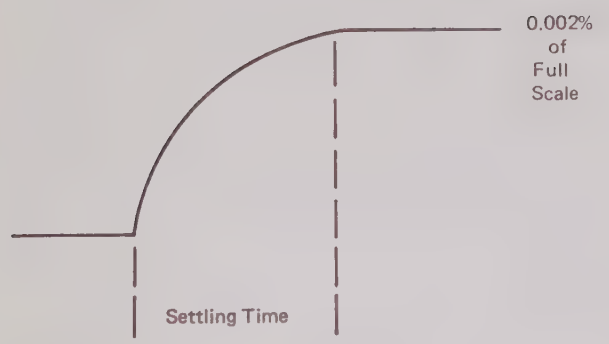


Figure 5-4. "Worst Case" Settling Time Within a Single Range.

change is 888.88, the settling time would be the same as in the 10-volt range.

When the signal input step is of sufficient amplitude and duration to cause the DMM to up range, an additional delay termed the range delay is introduced into the settling time. For example, assume the DMM is in the DC mode, in AUTORANGE and on the 1-volt range, and the input signal steps from zero to 88.888 volts—a 2-range change. Figure 5-5 shows the resultant delays with the three filter conditions.

ASSEMBLY FUNCTIONAL DESCRIPTIONS

The following descriptions relate the operation of each assembly and subassembly in the DMM. The diagram number referenced in parentheses after each assembly title is the number of the associated parts location and schematic diagram located in Section VI.

On schematic diagrams showing logic gates, those gates with a dot symbol are operated as NAND gates. Gates with a cross are operated as NOR gates. For ease in identification, gates, multivibrator flip-flops, and inverters are identified by their output pin number; for example, gate Z5 with input pins numbered 9, 10, 11, and 12 and output pin numbered 8 is designated as gate Z5-8.

The instrument logic is: +5 volts = true, 0 volts = false.

INPUT SELECTOR (DIAGRAM 2)

The Input Selector Assembly is comprised of switching relays and driver circuits.

The assembly:

1. Routes V, DC/DC and DC/AC ratio, and 4-wire KΩ measurement voltages through a relay on the 100 MΩ converter board to the Input Amplifier.

	A	B	C	TOTAL
FILTER OFF:	40 msec	200 msec	40 msec	280 msec
FILTER MED:	40 msec	200 msec	250 msec	490 msec
FILTER FULL:	40 msec	330 msec	650 msec	1020 msec

Figure 5-5. Range Delay Times.

AC, MV, AC/AC and AC/DC RATIO, HI Ohms, and LO Ohms measurement voltages are routed to the appropriate converter.

2. Routes the outputs of the converters to the Input Amplifier.

3. When the DMM is in the DC/DC or AC/DC RATIO function, routes the external reference voltage to the Comparator.

4. When the DMM is in the DC/AC or AC/AC RATIO function, routes the output of the AC Reference Converter directly to the Reference Amplifier.

5. In the KΩ measurement function, enables the DMM to change from 2-wire to 4-wire measurement when the measurement range is 1, 10, or 100 kilohms.

All voltages being measured are applied from the front panel HI and LO connectors to terminals DVM IN HI and DVM IN LO respectively.

As shown in the Relay Logic table on diagram 2, relays K3 and K5 are energized when the DMM is in the DC measurement function. Sheet 1 of diagram 3 shows the signal flow paths through the Input Selector to the Input Amplifier. Terminals AC, QR3, HIΩ, $\overline{\text{MV}}$, $\overline{\text{HIΩ}}$, DCL, $\overline{\text{QR3}}$, and $\overline{\text{LOΩ}}$ are controlled by the Autorange Assembly. Terminals $\overline{\text{AC/AC RATIO}}$ and $\overline{\text{DC RATIO}}$ are controlled by the front panel switches while terminal $\overline{\text{RC}}$ is controlled by the Function Decimal Assembly.

In the AC measurement function, relays K1 and K3 are energized. Sheet 1 of diagram 3 shows the signal path through the Input Selector to the AC Converter. The output of the AC Converter is fed through K1 of the Input Selector to the Input Amplifier.

In the MV measurement function, relays K2, K3, and K4 are energized. Sheet 1 of diagram 3 traces the signal flow through the Input Selector to the chopper-stabilized amplifier on the HIΩ-MV Converter. The output of the HIΩ-MV Converter is routed through relay K2 of the Input Selector to the converter input of the Input Amplifier.

In the 2-wire KΩ measurement function, relays K2, K3, and K4 are energized.

In the 2-wire mode:

1. Terminals HIΩ-MV LO and HIΩ-MV OUT are connected together at the HIΩ-MV Converter, as shown on sheet 2 of diagram 3.

2. A precision constant direct current is furnished from the ohms converter section of the HIΩ-MV Converter to terminals HIΩ-MV HI and HIΩ-MV LO. From the terminals the current is routed through contacts of relays K3, K4, and K6 to the external resistance being measured.

3. The voltage drop across the external resistance is sensed by the ohms converter section at terminals HIΩ-MV HI and HIΩ-MV LO.

4. The output of the HIΩ-MV Converter is applied to terminal HIΩ-MV OUT and routed to the Input Amplifier through relay K2 of the Input Selector.

When the DMM is in the V, AC, MV, LO-OHMS, 100 MΩ, 2-wire HIΩ and all ratio modes, analog common is connected to the Input Amplifier through normally closed contacts of relay K6 as shown in diagram 3.

When terminals $\overline{\text{MV}}$, and $\overline{\text{HIΩ}}$ are grounded the DMM is in the 4-wire KΩ measurement function and relays K3, K4, K6, K7, and K10 are energized.

In the 4-wire mode:

1. A precision constant direct current is furnished to the external resistance being measured through the front panel +REF IN and –REF IN terminals.

2. The voltage drop across the external resistance is applied to the Input Selector through the front panel HI and LO terminals. The signal flows through relay contacts on the Input Selector to the Input Amplifier.

In the LO OHMS measurement function, relays K2, K3, K4 and K7 are energized. As shown in diagram 3 the LO OHMS measurement utilizes a 4-wire measurement technique. A precision constant current is supplied to the LOΩ HI and LOΩ LO leads from a floating reference supply. This current is routed through the Input Selector and the + and – front panel terminals to the external resistance. The E HI and E LO terminals sense the voltage drop across the resistance and route it through the Input Selector to the MV section of the HIΩ-MV Converter.

In the 100 MΩ measurement function, relays K1-1 and K1-4 are energized which disconnects the front panel HI and LO connectors from the Input Selector and connects them directly to the 100 MΩ Converter. Relay K1-3 connects the output of the 100 MΩ Converter directly to the Input Amplifier while K1-2 connects the guard shield to analog common for maximum protection against leakage.

In the DC RATIO function, relays K3, K5 and K9 are energized. The input signal is routed through the Input Selector to the Input Amplifier as in the DC measurement mode.

The external DC reference voltage is applied to the + and – reference inputs on the front panel and routed through the Input Selector to the Reference Amplifier.

In the AC RATIO function, relays K1, K3, and K8 are energized. The input signal is routed as in the AC measurement mode. The external AC reference voltage applied to the front panel reference terminals is routed through the Input Selector to the AC Reference Converter. The output of the reference converter connects directly to the Reference Amplifier.

AC CONVERTERS (DIAGRAM 4)

Two AC Converters may be installed in the DMM; one as an AC signal input converter and the second as a reference input converter. The converters are identical and interchangeable.

AC Signal Input Converter

The AC Signal Input Converter, which is comprised of an input amplifier and a rectifier-amplifier, rectifies an AC input voltage and applies it through the Input Selector to the Input Amplifier. The output of the AC Converter is 1.09999V full scale.

The input signal is received at terminals IN HI and IN LO from the Input Selector and applied to input amplifier A1. Amplifier A1 is a wideband, operational amplifier with a high impedance, field effect transistor input.

The gain of amplifier A1 is about 2.2 in the 1-volt range, 0.22 in the 10-volt range, 0.022 in the 100-volt range, and 0.0022 in the 1000-volt range.

In the 1-volt range the feedback path is through R4, R5, C4, and C5 from the divider R12, R13, and C15. Terminals CR2, CR3, and CR4 are connected to the Autorange Assembly. In the 10-volt range (range 2) relay K1 is energized, in the 100-volt range K2, and in the 1000-volt range K3. Except when in the 10-volt range, the 10-volt feedback network is connected to analog common through normally closed contacts of K1. This arrangement minimizes the distributed capacity effect of the feedback networks.

The output of amplifier A1 is coupled through C18 to the rectifier-amplifier. The rectifier-amplifier is a unity gain, operational amplifier comprised of transistors Q1 through Q5. The push-pull output of the amplifier is fed back through CR12 and R27, and CR13 and R28 to the amplifier input. The half cycle of feedback at the junction of CR12 and R27 is applied through R40 where it is algebraically summed with the input voltage. The resulting voltage is applied as output voltage through terminal AC OUT to the Input Selector where it is filtered.

Potentiometers R5, R7, R9, and R11 and variable capacitors C5, C7, C9, and C14, and potentiometer R20 are calibration controls accessible through the top shield. Potentiometers R5, R7, R9, and R11 are the AC LO calibration controls and C5, C7, C9, and C14 the AC HI controls. Potentiometer R20, the AC ZERO ADJ control, is used to adjust the rectifier amplifier to the center of its operating range.

Terminal ACLC provides common to the Display Driver to enable the front panel AC function indicator. The indicator is illuminated when the AC function has been selected.

AC Reference Input Converter

The AC Reference Converter is identical in operation to the AC Signal Converter, except that the range selection is controlled by the REFERENCE EXT 1, 10, 100, and 1K switches. The output of the AC Reference Converter goes to the REFERENCE AMPLIFIER.

HIΩ-MV CONVERTER (DIAGRAM 5)

The HIΩ-MV Converter Assembly:

1. In millivolt measurement function, amplifies the millivolt input signal by 100 or 1000 to provide a 10.9999-volt full scale input to the Input Selector.

2. In resistance measurement function, supplies a precise current through the resistance under measurement to develop a voltage proportional to the value of the resistance. The 10.9999-volt full scale voltage is the input to the Input Selector.

The HIΩ-MV Converter is a chopper-stabilized dual purpose unit which, by switching, utilizes the circuitry as a voltage follower with gain in the millivolt measurement configuration (figure 5-6) or an operational amplifier in the resistance measurement configuration (figure 5-7).

Millivolt Measurement

The input to the converter is received from the Input Selector at terminals HIΩ-MV HI IN and HIΩ-MV IN LO. The input is filtered and applied to a chopper comprised of metal oxide semiconductor and to

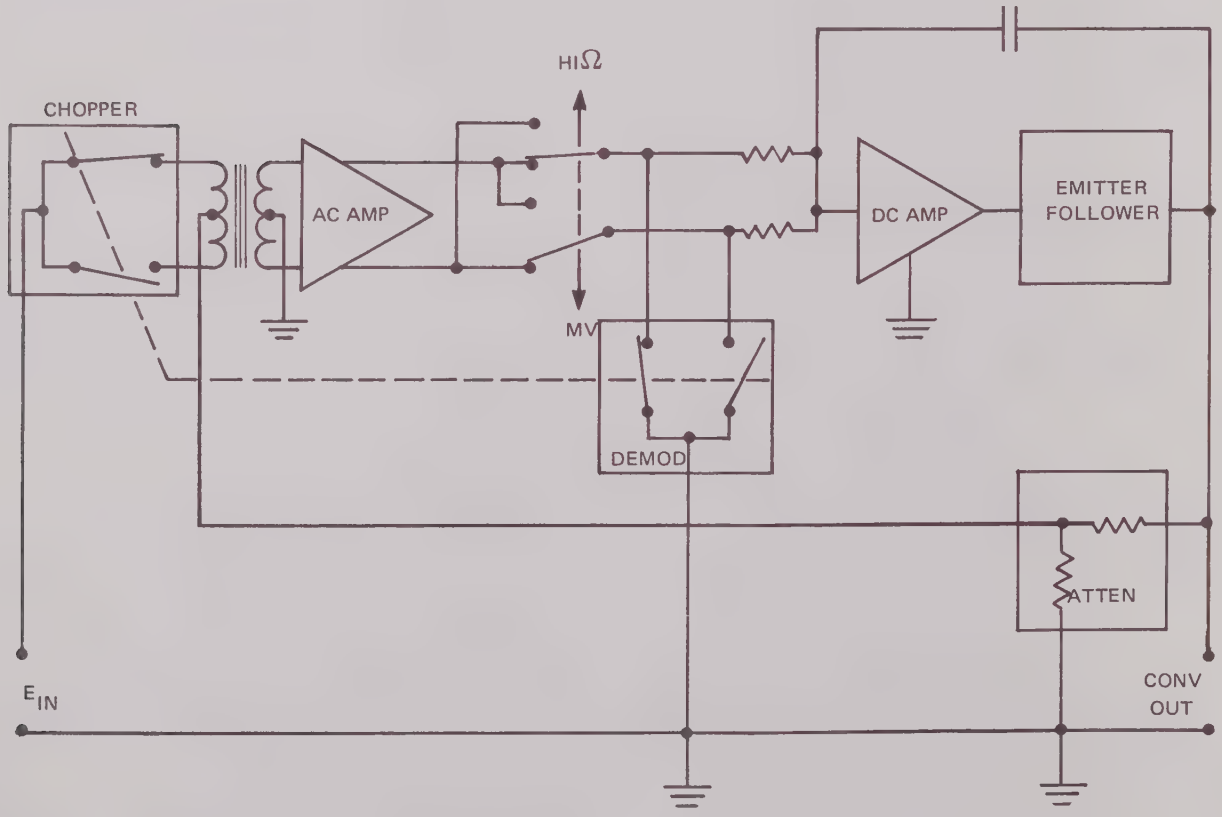


Figure 5-6. Millivolt Measurement Configuration.

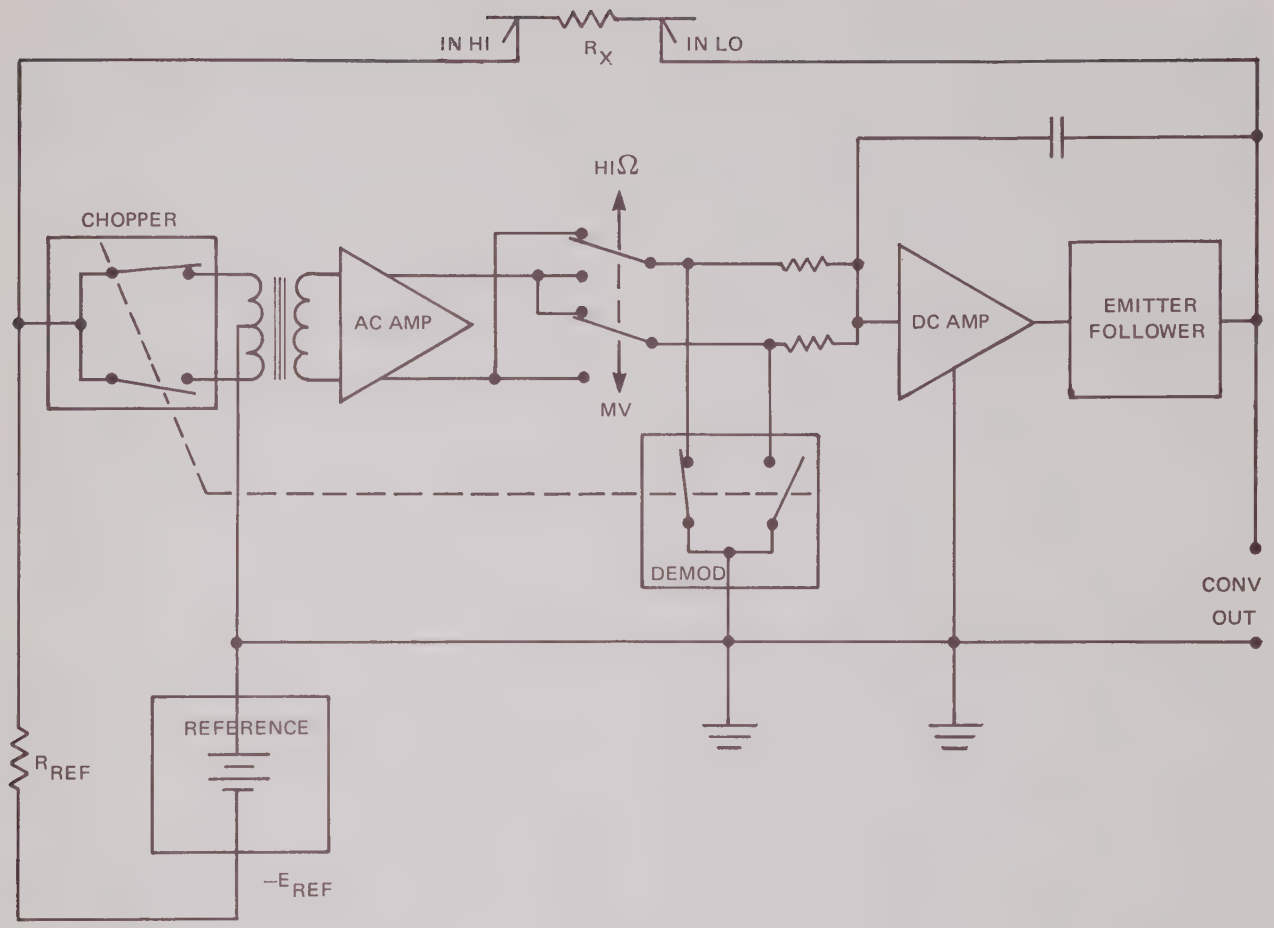


Figure 5-7. Resistance Measurement Configuration.

field effect transistors (MOS FET) Q3 and Q4. The chopper compares the input with the feedback at the centertap of the primary winding of transformer T1. Any difference between the two voltages is amplified by the AC amplifier comprised of transistors Q6 through Q10.

The output of the AC amplifier is routed through normally closed contacts of relay K7 and demodulated. Demodulator transistors Q11 and Q12 are in phase with the chopper. The demodulated signals are applied to the input of an integrating amplifier comprised of the integrated-circuit amplifier A1, emitter followers Q13 and Q14, and integrating feedback capacitor C11. The output of the integrating amplifier is fed back through the millivolt feedback attenuator to the centertap of transformer T1. The output is also applied through terminal HIΩ-MV CONV OUT to the Input Selector and thence to the Input Amplifier.

When the DMM is in the MV function, terminal HIΩ is at zero and turns off transistor Q5. In the 10 MV range the feedback path from the integrating amplifier is via normally closed contacts of relay K7, R32 and potentiometer R33. In the 100 millivolt range, a zero level at terminal MVL or LOΩ will energize relay K6 paralleling R32 and R33 with resistor R22 and potentiometer R23. The output of the millivolt feedback attenuator is applied to the centertap of the primary winding of transformer T1. The overall closed loop DC gain, as adjusted by potentiometers R23 and R33 is X1000 in the 10-millivolt range and X100 in the 100-millivolt range. The output of the front-panel-mounted 20 kilohm potentiometer is also applied to the centertap of transformer T1 through terminal MV "O". The potentiometer is used to adjust the assembly for zero output with a shorted input.

The chopper drive signal is generated by a free-running multivibrator comprised of integrated circuit Z1 and R2,

R1, C2 and C4. The output drives transistors Q1 and Q2 which in turn drive chopper transistors Q3 and Q4 and demodulator transistors Q11 and Q12. Terminal HIΩLCMV provides DVM common to enable the front panel HIΩ and MV function indicators. The indicators are illuminated by signals from the Autorange.

Potentiometers R37, and R44 are calibration controls accessible through the top shield. Trimmer C5 is the MV NULL control and is used to compensate for distributed input capacitance; R44 and R37 are the 10 MV and 100 MV controls respectively, and are used to adjust the feedback during calibration.

Resistance Measurement

The converter is switched to resistance measurement by application of a logic level 1 on the HIΩ terminal from the Autorange Assembly. Transistor Q5 is turned on energizing relay K7. When the DMM is in the HIΩ function, relay K6 is deenergized.

When relay K7 is energized:

1. The millivolt feedback attenuator is disconnected from the output which leaves the centertap of the transformer primary connected to analog common through R26. The chopper now compares the input signal to analog common instead of to a portion of the output.

2. Terminal HIΩ-MV IN LO is disconnected from analog common and connected to the output of the integrating amplifier.

3. The inputs to the demodulator are reversed, changing the phase of the output with respect to the input by 180°.

Terminals QR3, $\overline{QR3}$, RC, RB, and RA are connected to the Autorange Assembly. In range 1, relay K5 is energized by gate 6 of Z4. When K5 is energized, reference resistors R17 and potentiometer R18 are connected in series between the chopper inout and −11 volts received at terminal −11V from the Reference Amplifier. The sequence of events are identical in ranges 2, 3, 4, and 5. The reference currents provided for the 1, 10, 100, 1K, and 10K resistance ranges are 10 milliamperes, 1 milliampere, 100, 10, and 1 microamperes respectively, and are adjusted by potentiometers R18, R16, R13, R10, and R4. The potentiometers are the 1 KΩ, 10 KΩ, 100 KΩ, 1 MΩ, and 10 MΩ calibration controls accessible through the top shield.

When an external resistor is connected between terminal HIΩ-MV HI IN and HIΩ-MV IN LO terminal, the operational amplifier is complete. The input resistor is the reference resistor, the input voltage is the −11 volts, and the gain-setting feedback resistor is the external unknown resistor under measurement. The input resistor and input voltage are both fixed. Therefore, the output voltage from the operational amplifier is proportional to the gain, which is determined by the external unknown resistor under measurement.

100 MΩ RANGE (DIAGRAM 6)

The 100 MΩ Range Assembly consists of amplifier A1 with a discrete FET input, transistor Q1, connected as an inverting operational amplifier. An input current is developed proportional to the voltage drop across R3, R4 and the −11 volt reference. The external resistance to be measured is connected as the feedback resistor for the operational amplifier via relay K1. K1, held in by Q2, is deenergized by a zero level at terminal MΩL or KD3. Because of the high impedance of the summing junction, the input current is forced to flow in the external resistance completing the feedback loop, which then develops a voltage drop proportional to its resistance. This voltage is sensed by the Input Amplifier via relay K1-3 and displayed as an ohms value.

LOW OHMS CONVERTER (DIAGRAM 7)

The Low Ohms Converter Assembly is also shown in simplified form on sheet 2 of diagram 2. Zener diode CR9, transistor Q1, and amplifier A2 form a stable DC reference voltage. This voltage is applied through precision resistors via relays K1 through K6 to the summing junction of amplifier A1. The reference voltage across the precision resistor causes a precision constant current to flow. This current is supplied to the external resistance to be measured through terminals I-HI and I-LO and the Input Selector. The voltage drop across the external resistance, which is proportional to

its resistance, is sensed by the HIΩ-MV converter through the Input Selector. The output of the HIΩ-MV converter is applied to the Input Amplifier through the Input Selector. Range selection is controlled by input lines RC, QR3, $\overline{QR3}$, RB, RA, and LOΩ from the Autorange Assembly. These lines are decoded as shown in the table on diagram 7, and energize relays K1 through K6. The resistors switched into the circuit by K1 through K6 vary the output current in decade steps, thereby changing the range.

In order to minimize ground loop errors the Low Ohms Converter has a separate power supply so that it can "float" with respect to analog common. This regulated supply consists of amplifiers A3 and A4, transistors Q3 to Q6 and reference diodes CR13 and CR14.

INPUT AMPLIFIER (DIAGRAM 8)

The Input Amplifier Subassembly consists of an input signal attenuator, input amplifier, passive and active filters, and an inverting amplifier.

The Input Amplifier:

1. Attenuates the input signal voltage to the 10-volt range when the DMM is in V or RATIO function and the input signal voltage exceeds 11 volts.

2. Provides a high input impedance.

3. Minimizes input signal distortion.

4. Provides buffering between the Input Amplifier and the Comparator.

When the DMM is in V or RATIO function, the input signal is applied to terminals INPUT HI and LO from the Input Selector, if installed; otherwise direct from the front panel input signal connectors.

When the DMM is in V or RATIO function and the 1V or 10V range is selected, transistor Q2 conducts, energizing relay K2 which places R9 in parallel with R8.

In the 100V range Q3 conducts which energizes relay K3, shorting R12 to analog common. The input signal is routed through voltage divider R8, R11, and R12 and divided by a factor of ten.

In the 1000V range Q4 conducts which energizes relay K4, shorting R19 to analog common. The input signal is routed through voltage divider R8, R18, and R19 and divided by a factor of one hundred.

When the DMM is in the AC function the AC Converter converts the input signal to 1.09999 VDC full scale. In the MV or KΩ function, the HIΩ-MV Converter converts the input signal to 10.9999 VDC full scale. The outputs of the converters are applied through terminal CONV. INPUT directly to Active Filter amplifier A1.

Relay K1, energized by signals from the Autorange Assembly selects either the output of the Input Selector for DC and RATIO Functions or the output of the converter active filter A1 for all other functions as the input to amplifier A2.

Amplifier A1 is connected as an active filter which provides filtering of the converter output signals.

Amplifier A2 is a field effect transistor (FET) input operational amplifier connected potentiometrically. It provides an extremely high input impedance. The output of A2 is fed back to the negative input to control amplifier gain and minimize input signal distortion. In the 1-volt range, feedback is through resistors R28 and R31 and the gain is 10-to-1. In the 10-, 100-, and 1000-volt ranges, relay K5 is energized by means of a signal applied from gate 6 of Z1. When K5 is energized, R28 and R31 are bypassed and the amplifier gain is 1-to-1.

The output of A2 is routed through terminal IN A1 to the Filter Subassembly. The output of the Filter drives operational amplifier A3 through terminal IN A2. Amplifier A4 decouples the Input Amplifier from the Comparator.

Potentiometers R12, R19, R31, R32 and R38 are calibration controls accessible through the DMM top shield. Potentiometers R12 and R19 are used to balance their respective voltage dividers. In the 1-volt range, R31 is varied to adjust the output of amplifier A2 to zero volts with zero volts input.

Potentiometers R32 and R38 are used when making operational adjustments. The gain of amplifier A3 is controlled by varying R32. Potentiometer R38 is varied to adjust the output of A3 to zero volts with zero volts input.

Potentiometer 1A1-R4, DCØ is mounted on the instrument front panel and is screwdriver adjusted. It is effective only when the instrument is in the 1-volt range and is used to zero the front panel numerical readout when no input signal is present.

Transistors Q6 and Q7 are connected as low-leakage diodes. They prevent the voltage difference between the two inputs to amplifier A2 from exceeding 0.7 volt. Diodes CR14 and CR15 serve the same purpose for amplifier A3.

Zener diodes CR16 and CR17 reduce the +22 and −22 voltage supply to +18 and −18 volts required by amplifier A2. Zener diodes CR18 and CR19 perform the same function for amplifier A3.

When the instrument is in V, RATIO, AC, MV, or 2-wire KΩ measurement mode, terminal ΩØ is connected through the Input Selector to analog common. When the instrument is in 4-wire KΩ measurement mode, terminal ΩØ is connected through the Input Selector to the low-voltage side of the external resistance being measured.

FILTER (DIAGRAM 9)

The Filter Subassembly is composed of two sections. Relay K1 and K2, amplifiers A1 and A2, and associated components comprise the input signal voltage filter section. Relays K3 and K4, amplifiers A3 and A4, and associated components comprise the reference voltage filter section.

Input signal voltages are received from the Input Amplifier at terminal 1N1A. If neither of the front panel FILTER switches are depressed, the signal voltage is routed back to the Input Amplifier with no filtering.

Operational amplifiers A1 and A2 and their associated components are active filters. When the front panel FILTER MED switch is depressed, relay K1 is energized by means of a ground applied through terminal $\overline{\text{MFD}}$. Most of the AC ripple present on the signal voltage is shunted to common through passive filter capacitor C1 and one set of contacts of relay K1. The remaining ripple is applied through the other set of K1 contacts and capacitor C2 to the input of amplifier A1. Amplifier A1 amplifies and inverts the ripple voltage and applies it to the input through capacitor C6. The out-of-phase feedback reduces the ripple to a very low level. When the FILTER MAX switch is depressed, relay K1 is held in an energized state and relay K2 is also energized. Ripple voltage is filtered by capacitors C1 and C5 and amplifiers A1 and A2.

Operation of the reference voltage filters is identical to the input signal voltage filters.

Potentiometers R6, R10, R16, and R22 are factory-set amplifier gain controls that control both the degree and speed of filtering of the amplifiers. They are mounted on the assembly beneath the top shield.

Figure 5-8 shows the instrument filter response with medium and full filtering. At 60 hertz the Medium Filter rejection is 40 decibels and the Maximum Filter rejection is 90 decibels. At 400 hertz the Medium Filter rejection is 80 decibels and the Maximum Filter, by extrapolation, 200 decibels or greater.

COMPARATOR (DIAGRAM 10)

The Comparator Subassembly is comprised of the comparator amplifiers A1 and A2, a dual comparator A3, and a temperature controlled reference module A4.

The Comparator:

1. Amplifies the summing junction output.
2. Senses increases or decreases in input signal amplitude and generates pulses to drive the control logic.
3. Enables control of DMM sensitivity.
4. Generates a stable internal reference voltage.
5. Enables selection of either the internal reference voltage or an external reference voltage.

Comparator Section

The input signal is received from the Input Amplifier at terminal AMP 1. The output of the resistance ladder

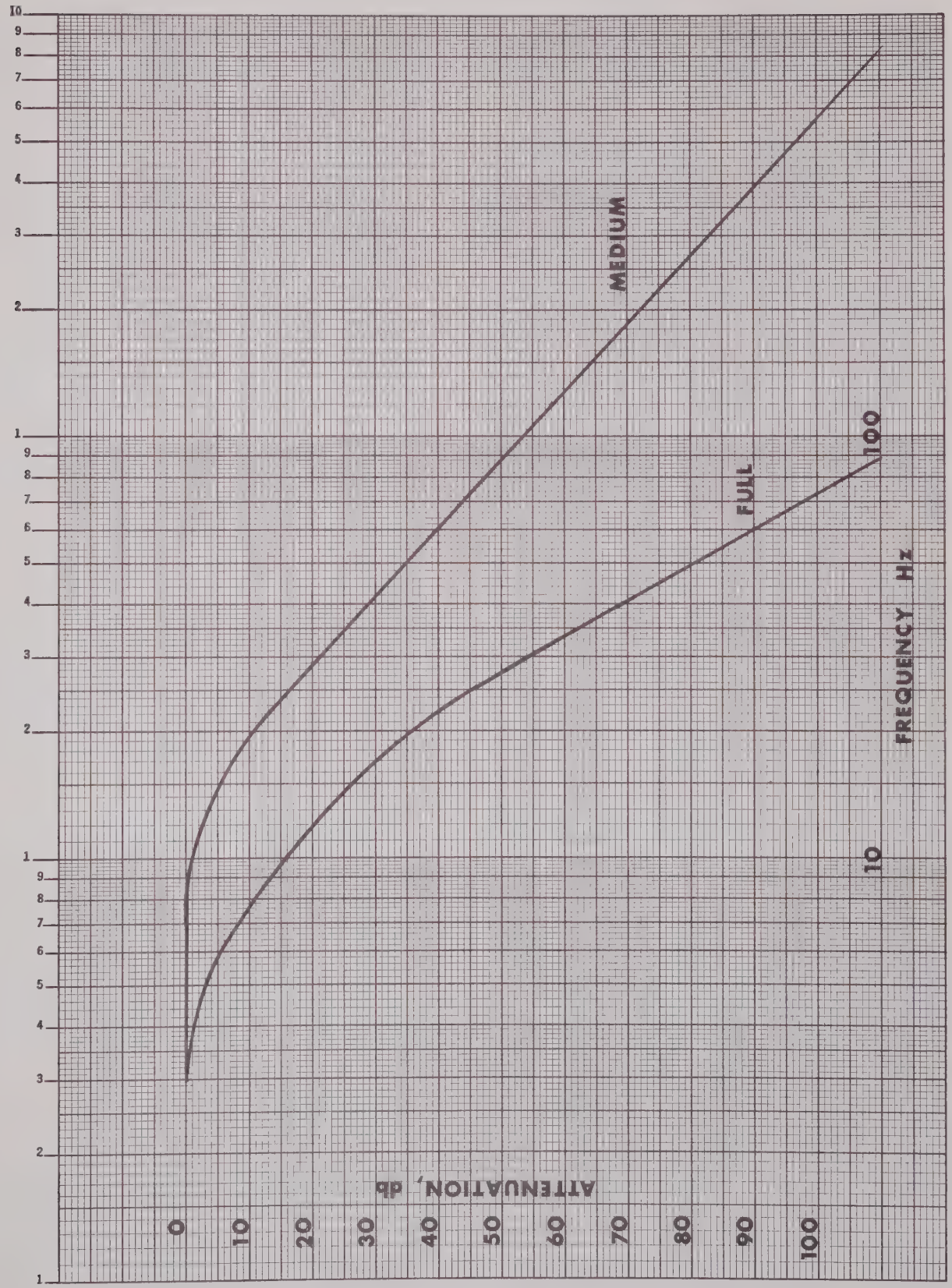


Figure 5-8. Filter Response.

is received from the Ten Thousands Decoder at terminal Decoder OUT. The two inputs are algebraically summed and applied to the input of amplifier A1.

Amplifier A1 amplifies and inverts the signal and applies it to amplifier A2, where it is again amplified. The output of A2 is applied to A3, a dual comparator consisting of a positive comparator (pins 5, 6, and 8) and a negative comparator (pins 12, 13, and 1). The negative comparator has a nominal bias of +0.3 volt applied to pin 13. When the DMM is in a null condition, the bias holds the comparator at cutoff and the output is –0.3 volt. When the signal from amplifier A2 drives A3, pin 2 more positive than the pin 12 bias, the comparator fires and the output changes to +3 volts. The negative comparator is biased at –0.3 volt nominal at pin 5, at null the output is –0.3 volt. When the input signal at pin 6 is more negative than the bias voltage, the comparator fires and the output changes to +3 volts.

When the input signal is positive in polarity and increasing in amplitude, the output of amplifier A2 is positive and A3 positive comparator is constantly firing. When the positive input signal is decreasing in amplitude, the output of A2 is positive and the negative comparator is constantly firing. When the polarity of the input signal changes and the signal increases in amplitude in a negative direction, the A2 output is negative and the positive comparator is firing. If the negative input signal is decreasing in amplitude, the A2 output is positive and the negative comparator is pulsing. The outputs of the comparators are applied through terminals –COMP and +COMP to the Units Decade and Control Logic.

When front panel SENSITIVITY, X2, 16, or 4 switches are depressed, commands are received at terminals $\overline{S2X}$ or $\overline{S4}$ from the Autorange Assembly and at S1G direct from the SENSITIVITY 16 switch. The commands energize relays that control the amount of feedback in amplifiers A1 and A2 and thereby determine amplifier gain and DMM sensitivity. For a more detailed explanation of gain and sensitivity, refer to the discussion titled Instrument Sensitivity immediately following the Block Diagram and Counting Logic Description.

Resistor R14 is part of a ratio-matched set. The other resistors are located on the One Thousand and Ten Thousands Decoder Subassemblies.

Potentiometers R11, R15, R20, and R31 are calibration controls accessible through the DMM top shield. The biasing voltages of the positive and negative comparators are set by adjusting R21 and R20 respectively.

Potentiometers R11 and R15 are factory adjustments. If it is necessary to replace either A1 or A2 amplifiers, the A-B jumper connection at the input to A1 is changed to A-C. The inputs to A1 and A2 are then zeroed by adjusting R11 and R15 respectively.

The diode networks CR1 through CR8 are bounding networks. They prevent amplifier A1 from saturating. Transistors Q1 and Q2 are connected as low leakage diode clamps and prevent amplifier A2 from saturating.

Zener diodes CR14 and CR16 establish the operating voltages of + and –18 volts for amplifiers A1 and A2. Zener diodes CR15 and CR17 establish the operating voltage of +12 and –7 volts for dual comparator ZA1.

Reference Module Section

The reference module A4 provides a highly stable reference voltage across voltage divider R34, 35, 37 and 38. R35 and 38 are calibration controls accessible through the DMM top shield. R35 is the ref. coarse adjust and R38 is the ref. fine adjust. The positive internal reference voltage appears at terminal 3 of relay K6.

Relays K6 and K4, energized by a zero level on lines $\overline{\text{RATIO RNG}}$ and $\overline{\text{DC RATIO}}$, select either the internal reference, or an external reference applied to terminals +REF EXT and –REF EXT. Relay K5 is energized by a zero on terminal $\overline{\text{MRR3}}$ when the ext 100V range switch is depressed. Relay K5 connects divider R28, R29, and R30 in the external reference signal path to provide a X10 attenuation. The reference voltage is fed to the Reference Amplifier via terminal +REF.

REFERENCE AMPLIFIER (DIAGRAM 11)

The Reference Amplifier Assembly consists of reference filter amplifier A1, buffer amplifier A2, auto bipolar amplifiers A3, and A4, and reference buffer amplifiers A5 and A6. When in any function except AC/AC

ratio, the reference voltage from the Comparator is applied to amplifier A2 via the normally closed contacts of relay K1.

In the AC/AC ratio mode relay K1 is energized by a "0" level at terminal $\overline{AC/AC}$. This connects the output of active filter A1 to the input of A2. The input of A1 is driven by the AC Reference Converter through terminal AC REF OUT. In the 10 and 100 volt external reference ranges, A2 functions as a unity gain buffer amplifier. In the X1 reference range relay K2 is energized by a zero level at terminals $\overline{AC/AC}$ or $\overline{MRR1}$. Relay K2 causes R10 and R12 to be connected in the feedback loop of A2 increasing its gain to 10.

Amplifier A3 is connected as a unity gain inverting amplifier whose output is the opposite polarity of A2. Amplifier A4 detects the output polarity of amplifier A2, or in effect, the polarity of the reference input signal. If the output of A2 is negative, the output of A4 goes positive turning on transistor Q2 which energizes relay K3. The arm of relay K3 now switches to apply the positive output of A3 to terminal REF A1. The phasing of A2, A3, A4, and relay K3 is such that the polarity at terminal REF A1 is always positive regardless of the reference input polarity. The Reference Filter is connected between terminals REF A1 and REF A2. It provides filtering for any AC appearing at terminal REF A1.

The +10 volt reference signal at terminal REF A2 is applied to amplifier A5.

A5 is connected potentiometrically with a gain of 1.1 and an emitter follower output transistor, Q3. A5 provides the +11 volt reference for the DMM. A6 is a unity gain inverting amplifier with an emitter follower output transistor, Q4. Its input signal is the +11 volt reference. Its output is the −11 volt tracking reference voltage for the DMM.

The plus and minus 11 volt reference voltages are applied to the Decoders through terminals +11 and −11. The reference voltages are sensed at the Decoders and fed back to amplifiers A5 and A6 through terminals +11S and −11S.

Variations in the reference voltages are sensed by the sensing leads, fed back to the reference amplifiers and compensated for by the feedback action. Thus regulation at the decoders ensures a stable reference voltage for the ladder.

Potentiometers R12, R11, R16, R17, R26, R30, R37, and R38 are calibration controls accessible through the DMM guard shield.

R12 sets the gain of A2 to 10. R11 and R16 are used to zero the external reference amplifiers. R17 sets the gain of A3 to 1. R30 and R35 zero the reference amplifiers. R30 sets the gain of A5 to 1.1. R38 sets the gain of A6 to 1.0. CR8 and CR9 are low leakage diodes which prevents the input voltage of amplifier A2 from exceeding 0.7V. CR13 and CR14 clamp the output of A2. CR15 and CR16 establish proper output levels for A4. CR1 through CR6 drop the plus and minus supply voltages to the correct levels for amplifiers A1 through A6.

UNITS DECADE AND CONTROL LOGIC (DIAGRAM 12)

Diagram 12 is a schematic diagram of the Units Decade and Control Logic Assembly. Diagram 13, Voltage Change Timing, shows the sequence of events that occurs in the Comparator, the Units Decade and Control Logic, the Units Decoder, and the Ten Thousands Decoder during an input signal voltage change.

The Units Decade and Control Logic Assembly is comprised of a control logic section and a units decade section.

The control logic section:

1. Generates clock pulses that synchronize operation of the control logic section up and down drive logic circuits and the Decade and Autorange.

2. Develops up drive and down drive pulses and applies them to the units decade section and the Print Control Assembly.

3. Controls the polarity configuration of the DMM.

4. When the DMM is not in remote control and is in the repetitive tracking mode:

a. Controls the input signal sampling rate, as determined by the front panel REPETITIVE MODE potentiometer setting.

b. Controls DMM printout.

5. Sets all the Decades to a zero-state when the DMM power is turned on.

The clock, comprised of ZA9, ZA10, ZA11, and ZA12, operates at a four kilohertz rate. Clock action occurs with the trailing edge of a 20 microsecond, 5-volt pulse. The clock output is applied through terminal CLOCK to synchronize operation of the Tens, Hundreds, Thousands and Ten Thousands Decades and the Autorange Assembly. The output is also applied from ZA12 pins 6 and 8 to:

1. ZB13, pins 2 and 12 to synchronize operation of the gates.

2. ZA15 pins 1 and 13 to reset the flip-flops after they have been set.

3. Pin 2 of ZA3, ZA4, ZA5, and ZA6 in the units decade section to enable setting and resetting of the counters.

Assume that the DMM is not in remote control, is in constant tracking mode with the front panel PRINT AUTO switch depressed, and that the input signal is of positive polarity and increasing in amplitude.

Transistor Q3 is conducting, holding the emitter bias of unijunction transistor Q5 at zero and disabling the repetitive mode control circuitry.

Because the DMM is not in remote control or repetitive mode, the output of ZA2 gate 6 is positive. The output is applied to ZB13 pins 1 and 13. In the absence of a printout, the input to ZB13, pins 4 and 10 from terminal $\overline{\text{PRINT CLAMP}}$ is positive. Gates 6 and 8 of ZB13 are now enabled. A positive-going pulse is received at terminal –COMP from the negative comparator. The pulse is applied to ZB13 pin 5 and triggers ZB13 gate 6. The zero-state output of ZB13 gate 6 causes ZA15 flip-flop 6 to set, which in turn produces a positive output.

When all the Decades are in a zero count, a zero-state signal is received at terminal $\overline{\text{TK}\emptyset}$ from the Tens Thousands Decade. The signal is inverted and applied to ZB10 pin 13. Upon receipt of a +5-volt pulse through terminal KDT (Thousands Down Transfer) from the One Thousand Decade, ZB10 gate 8 is triggered. The resultant zero-state signal is inverted and applied to ZA13 pins 3 and 12. This input to ZA13, together with a lack of down pulses at pin 2, sets ZA13. Pin 6 of ZA13 goes positive and pin 9 is at zero state. The outputs are inverted at ZB11 pins 6 and 8. The output of pin 6 is applied to ZB12 pin 2 and ZA14 pin 5, disabling the gates. The output of ZB11 pin 8 is applied to ZB12 pin 12 and ZA14 pin 9, enabling those gates. The output of ZA15 flip-flop 6 is applied to ZA14 gates 6 and 8. However, gate 6 is disabled. Gate 8 is triggered and the zero-state output is inverted at ZA14 pin 11 and applied as up drive pulses to the master board through terminal UP. From the master board the pulses are routed to the Print Control and also back to the Units Decade and Control Logic through the second UP terminal thence to the units decade section.

The outputs of ZB11 inverter 6 and 8 are applied directly to the units decade section and through terminals –POL and +POL to the Tens through Ten Thousands Decade and Display Driver. The output of ZB11 inverter 6 is also inverted and applied through terminal POL SW DRIVE to the Polarity Switch on the Ten Thousands Decoder.

When the positive input signal is decreasing in amplitude, a positive output is received from the positive comparator. The DMM is in the positive polarity with pin 9 of ZA13 at a logic zero. The +LEVEL is received at terminal +COMP and applied to already enabled ZB13 gate 8. The zero-state output of gate 8 is inverted at ZA15 flip-flop 8 and applied to ZB12 gates 3 and 11. Gate 3 is disabled. Gate 11 is triggered and the resultant DN drive pulses are applied via the master board to the Print Control and also back to the units decade section.

When the input signal is 00000 and starts to increase in amplitude in a negative direction, a zero-state signal is received through terminal KDT from the One Thousands Decade. The signal disables ZB10 gate 8. The +5-volt output of ZB10 gate 8 is inverted and applied to flip-flop

ZA13. This input, combined with continuing down drive pulses, resets ZA13 causing pin 6 to go to zero-state and pin 9 to go positive. This condition enables ZB12 gate 3 and ZA14 gate 6 and disables ZB12 gate 11 and ZA14 gate 8. The polarity of the outputs at terminals +POL, –POL, and POL SW DRIVE are reversed and the instrument is in a negative polarity configuration.

As the negative input signal increases in amplitude, a +LEVEL is received at terminal +COMP. The output of ZB13 gate 8 is applied to ZB12 gates 3 and 11. Only ZB12 gate 3 is enabled and UP drive pulses are generated.

When the negative polarity input signal decreases in amplitude, pulses are received from terminal –COMP and applied to ZB13 gate 6. The output of gate 6 is applied to ZA14 gates 6 and 8. Only ZA14 gate 6 is enabled and DN drive pulses are generated.

During a printout, a zero-volt state signal is applied from the Print Control through terminal $\overline{\text{PRINT CLAMP}}$ to ZB13 gates 6 and 8. The gates are disabled and cannot pass up and down pulses. This condition continues until the Print Control receives a ready signal.

When the front panel REPETITIVE MODE switch-potentiometer is closed, terminal RM POT 3 is grounded and transistor Q3 is disabled. The emitter bias of unijunction transistor Q5 is now determined by the setting of the 100 kilohm RM POT. The repetitive mode sampling rate is controlled by the time constant of the RM POT and capacitor C9. Each time the charge on C9 rises to the required level, Q5 fires and discharges C9 through resistor R17. The voltage developed across R17 momentarily turns off Q6. When the DMM is not in remote control, +5 volts are applied to ZB11 pin 4. With Q6 off, +5 volts is applied to the input of ZB10 gate 6 and triggers the gate. The zero state output of gate 6 is inverted by ZB1 gate 11 and applied to ZA1 gate 11.

If the instrument is not in the HOLD mode, +5 volts is already applied to ZA1 gate 11. The +5 volts from ZB2 gate 11 results in a ZA1 gate 11 zero-state output. The output is inverted at ZA1 gate 3 and again at ZA1 inverter 6. The zero-state output of ZA1 inverter 6 keeps transistor Q4 turned off until capacitor C8 discharges sufficiently to turn it on again. The charging time of C8 is about 60 milliseconds. With Q4 off, the +5 volts through resistor R16 are inverted by ZA2 inverter 8 and applied to the input of ZA6 gate 6. The output of ZA2 gate 6, until now a negative output that disabled ZB13 gates 6 and 8, goes positive and enables ZB13 gates 6 and 8. Up or down pulses can pass through ZB13, gates 6 and 8 during the charging time of capacitor C8.

Input lines $\overline{\text{RRM2}}$ and $\overline{\text{RRM3}}$ enable gates 11 and 3 of ZB2. This parallels C8 with either C10 or C11, or both, which changes the charging time of C8 to 30 and 20 milliseconds respectively.

When the DMM is not in repetitive mode the output of ZA2 gate 11 is positive and is applied through terminal $\overline{\text{RME}}$ to the Print Control Assembly where it enables the null circuitry. In the repetitive mode the output goes negative and disables the null circuitry. During the 60 milliseconds that transistor Q4 is turned off, the zero-state output of ZA2 inverter 8 is applied through terminal REP. MODE PRINT ENABLE to the Print Control so it can issue a print command.

When the DMM is in remote control a zero-state signal is received from the Remote Buffer through terminal $\overline{\text{EXT RME}}$ (External Remote Enable). The signal disables the DMM repetitive mode circuitry by disabling ZB10 gate 6. It also disables the Print Control null circuitry through ZA2 gates 3 and 11.

Each time the remote unit issues a repetitive mode command, a zero-state pulse is received through terminal $\overline{\text{EXT RMP}}$ (External Repetitive Mode Pulse) from the Remote Buffer. The pulse is NANDed with EXT RME at ZB2 gate 3 and controls the operation of transistor Q4.

If the front panel PRINT HOLD switch is depressed when the DMM is in local repetitive mode operation, or if HOLD is programmed from the remote unit in remote repetitive mode, a zero-state signal is received at terminal $\overline{\text{HOLD}}$. The signal disables either type of repetitive mode operation by disabling ZA1 gate 11 and ZA2 gate 11.

When power is removed from the DMM the Decades assume random counting states. When power is reapplied, capacitor C5 starts charging through resistor R14. While C5 is charging, transistor Q1 is conducting and preventing any possible up drive pulses from the output of ZA14 inverter 11. A steady zero-state condition is

applied through R7 to ZA14 gate 3 where it is inverted and applied to the units decade section as a steady down drive condition. This condition, in conjunction with clock pulses, resets the units decade section, and subsequently all the other decades, to a zero-count state. When C5 charges, transistor Q2 is turned on. The point between R7 and R8 goes positive, turning off Q1 and causing ZA14 pin 2 to go positive. Normal up and down drive pulses are now enabled.

The units decade section:

1. Counts up 1, 3, 5, 7, and 9 in response to up drive pulses and clock pulses from the control logic section.

2. Counts down from an odd count to the next even count and then to zero in response to down drive pulses and clock pulses.

3. By means of a 1-2-4-2* BCD count, cause the Units Decoder resistance ladder to be switched to either the positive or negative reference voltage.

4. By means of a 1-2-4-8 BCD count, control the numeral readout in the front panel units window and provide printout information to Print Output Number 1.

Clocked flip-flops ZA3, ZA4, ZA5, and ZA6 comprise a serial counter. The counters are set when pins 3 and 4 are positive. Counters ZA3, ZA5, and ZA6 are reset when pins 11 and 12 are positive and ZA4 when pin 12 is positive. When set, pin 6 outputs are positive and pin 9 negative. The counters are set and reset during the absence of clock pulses at pin 2. Table 5-2 shows the state of the counter outputs during an up count to 9 and down count to zero.

The outputs of the logic gates that drive terminals $\overline{U1}$, $\overline{U2}$, $\overline{U4}$, and $\overline{U2^*}$ are applied to the Units Decoder to switch resistance ladder units to either the positive or negative reference voltage. The logic gates are enabled and disabled by polarity flip-flop ZA13 in the control logic section. The voltage of terminals $\overline{U1}$, $\overline{U2}$, $\overline{U4}$, and $\overline{U2^*}$ is either 0.0 or +0.6.

Table 5-2. Units Decade Counting Sequence.

UP COUNT	ZA3 1	ZA4 2	ZA5 4	ZA6 2*
1	1	0	0	0
3	1	1	0	0
5	1	0	1	0
7	1	1	1	0
9	1	1	1	1
DOWN COUNT				
8	0	1	1	1
0	0	0	0	0

Up drive pulses are applied to pin 3 of ZA3 and pin 4 of ZA4, ZA5, and ZA6 and set the counters. Down drive pulses are applied to pin 12 of ZA3, ZA5, and ZA6 and reset the counters. Down drive pulses are applied to ZA4 pin 12 through ZB6 gates 11 and 3.

When a positive voltage increasing in amplitude is applied to the DMM, a series of up drive pulses are applied to the units decade counters. The counters have been in a reset state with pin 9 positive. The ZA3 pin 9 output is applied back to ZA3 pin 4. The first up pulse is applied to ZA3 pin 3 and ZA3 is set. The resulting pin 6 positive output is applied to:

1. Terminal UL1 and thence to Print Output Assembly No. 1 for printout and to the Display Driver, causing a 1 to appear in the front panel units window.

2. Through ZB3 gate 11 and terminal U1 to the Units Decoder to switch the 1-weighted resistor to the +11 reference voltage.

3. ZA3 pin 11 to enable the counter for reset.

4. ZB8 gates 8, 12, and 6 and ZB7 gate 8.

Counters ZA4 and ZA6 are still reset. Their pin 9 positive outputs are applied to ZB8 gate 8. When the

ZA3 pin 6 output is applied to ZB8 gate 8 the gate is triggered. The output is inverted at ZA8 gate 6 and applied to ZA4 pin 3. The next up drive pulse is applied to ZA4 pin 4 and ZA4 is set. The pin 6 output of ZA4 is:

1. Combined with the pin 9 output of counter ZA6 and applied through terminal UL2 to Print Output No. 1 for printout and to the Display Driver to light the numeral 3 in the units window.

2. Applied through terminal $\overline{U2}$ to switch the Units Decoder 2-weighted resistor to +11 volts.

3. Applied to ZB8 gate 6 and ZB7 gate 8.

The ZA5 pin 9 output is also applied to ZB7 gate 8 and the gate is triggered. The output is inverted at ZA7 inverter 8. The output of inverter 8 drives ZA5 pin 3 positive and also enables ZA7 gate 11. The next up drive pulse is applied to ZA7 gate 11 and ZA5 pin 4. Counter ZA5 is set and ZA4, through ZA7 gate 11 and ZB6 gate 3 is reset. The ZA5 pin 6 output is applied to terminals U4 and UL4 and to ZB8 gates 6 and 12. A 5 now appears in the units window.

When ZA4 reset, the pin 9 output triggered ZB8 gate 8 and ZA4 pin 3 was driven positive. The next up drive pulse sets ZA4 and a 7 appears in the units window.

With ZA3, ZA4, and ZA5 set, ZB8 gate 6 is triggered and ZA6 pin 3 becomes positive. The next up drive pulse sets ZA6. A 9 appears in the units window and the 1-2-4-2* resistors in the Units Decoder are now all switched to +11 reference voltage.

The positive voltages of ZA6 pins 3 and 6 are applied to ZA8 gate 8. The output of the gate is inverted and applied to ZA7 gate 3. All following up drive pulses are also applied to ZA7 gate 3 and result in a series of units-up-transfer pulses being routed through terminal UUT to the Tens Decade and Print Control.

When the input signal decreases in value to zero, down drive pulses are generated. The first down drive pulse resets ZA3. The counters are now in an 8 count. When ZA3 reset, pin 9 went positive. The output of pin 9 is applied to ZB6 gate 11 and pin 11 of ZA5 and ZA6. The next down drive pulse resets ZA5 and ZA6 and, through ZB6 gate 11, ZA4. The units window displays a zero and the Units Decoder 1-2-4-2* resistors are all switched to the –11 reference voltage.

When all the unit counters are reset, ZB7 gate 6 is triggered and the output is applied to ZB6 gate 8. Additional down drive pulses are also applied to ZB6 gate 8 and result in units-down-transfer pulses being routed through terminal UDT to the Tens Decade and Print Control.

If the input signal had decreased to .00006 volt and remained at that value, the Comparator would sense the error between the zero-state of the units decade and the input signal value. Up drive pulses would be generated until the units decade was in a 7 count. Again the Comparator would sense the error and a single down drive pulse would be generated to reset ZA3, resulting in a 6 count.

TENS AND HUNDREDS DECADE (DIAGRAM 14)

The Tens and Hundreds Decade Assembly controls the numerical readouts in the front panel tens and hundreds windows and switching of the 1-2-4-2* weighted resistors in the Tens and Hundreds Decoders.

The counting logic and operation of the decoders are the same as the units decade. The polarity states, clock pulses, units-down-transfer, and units-up-transfer pulses are received from the Units Decade and Control Logic Assembly at terminals +POL, –POL, CLOCK, UDT, and UUT.

The Tens Decade section tens-up-transfer and tens-down-transfer pulses are applied to the Hundreds Decade section from the outputs of ZA5 inverter 8 and ZA6 inverter 8, and to the Print Control through terminals TUT and TDT. The hundreds-up-transfer and hundreds-down-transfer pulses are applied to the Thousands Decade through terminals HUT and HDT.

ONE THOUSAND AND TEN THOUSANDS DECADES (DIAGRAM 15)

The One Thousand and Ten Thousands Decades Assembly controls the numerical printouts and readouts

in the front panel thousand and ten thousands windows and switching of the 1-2-4-2* weighted resistors in the Thousand and Ten Thousands Decoders.

The polarity states and clock pulses are received from the Units Decade and Control Logic at terminals +POL, –POL, and CLOCK and applied to both decade sections. The hundreds-up-transfer and hundreds-down-transfer pulses are received from the Hundreds Decade and applied to the One Thousands Decade section.

The One Thousands Decade counting logic and operation are the same as the Units Decade, with one exception. When all the counters are reset, their pin 9 outputs are gated at ZC5 gate 8. The inverted output of gate 8 appears at ZA6 gate 6. If hundreds-down-transfer pulses continue to be received from the Hundreds Decade, ZA6 gate 6 is triggered. The output is inverted and applied through terminal KDT to the Units Decade and Control Logic.

Thousands-up-transfer and thousands-down-transfer pulses are applied from the outputs of ZA5 inverter 8 and ZA6 inverter 8 to the Ten Thousands Decade.

The Ten Thousands Decade counting logic is similar to the Units Decade. The Ten Thousands Decade counts up 1, 3, 5, 7, 9, and, when an overrange condition exists, 10, and then up range. When counting down from an overrange condition, the decade counts 10, 9, 8, 1, 0, and then polarity change. In any state other than 10, it counts down from an odd-numbered state to the even-numbered state and then to 1. The next two down pulses cause the decade to count to zero then polarity change.

Counters ZA8, ZA9, ZA10, and ZA11 are the 1-2-4-2* counters respectively. Counter ZA12 is the 10 or overrange counter. Thousands-up-transfer (KUT) pulses are applied to pin 4 of all the counters except ZA8. The pulse is applied to pin 3 of ZA8 through ZB2 inverter 11 and ZC13 gate 6. Thousands-down-transfer (KDT) pulses are applied directly to pin 12 of ZA12, through ZA14 gate 11 and inverter 8 to pin 12 of ZA8, ZA10, and ZA11, and through ZB2 gates 8 and 6 to pin 12 of ZA9.

The first KUT pulse sets ZA8. The pin 6 output is applied to ZC11 gates 6, 8, and 12, and ZC12 gate 8. Counters ZA9 and ZA11 are reset. Their pin 9 outputs are also applied to ZC11 gate 6. Counter ZA9 pin 3 goes positive. The next KUT pulse sets ZA9.

The ZA9 pin 6 output is applied to ZC11 gate 12 and ZC12 gate 8. Counter ZA10 is reset and the pin 9 output is also applied to ZC12 gate 8. The output of ZC12 gate 8 is inverted, applied to ZB2 gate 3 and to ZA10 pin 3. The next KUT pulse sets ZA10 and, through ZB2 gate 3 and 6, resets ZA9. Counter ZA10 pin 6 output is applied to ZC11 gates 8 and 12. The ZC11 gate 8 output drives ZA9 pin 3 positive. The next KUT pulse sets ZA9.

The pin 6 outputs of ZA8, ZA9, and ZA10 are applied to ZC11 gate 12 and ZA11 pin 3 goes positive. The next KUT pulse sets ZA11. The 1-2-4-2* weighted resistors in the Ten Thousands Decoder are switched to the +11 reference voltage and the front panel ten thousands window displays a 9.

With the 1-2-4-2* counters set, the output of ZA11 pin 6 is applied to already enabled ZA14 gate 3. The output of ZA14 gate 3 drives ZA12 pin 3 positive and is also applied to ZA13 gate 3. The next KUT pulse sets ZA12. When ZA12 sets, the decade is in a 10-state and:

1. The negative output of ZA12 pin 9:

   a. Disables the outputs at terminals TKL1, TKL2, TKL4, and TKL8.

   b. Is inverted and applied through terminal KOR to the Function Decimal decoder, Display, and to Print Output No. 2.

   c. Disables ZC10 gate 3.

   d. Is applied to ZA14 gate 11, triggering the gate. The output of the gate is inverted and applied directly to pin 12 of ZA8, ZA10, and ZA11 and pin 12 of ZA9 through ZB2 gates 8 and 6. The 1-2-4-2* counters cannot be reset until ZA12 is again reset.

2. The positive output of pin 6:

   a. Disables ZC10 gate 6. The positive output of the gate is applied through terminal $\overline{OR}$ to the Ten Thousands Decoder where it switches the overrange resistor to the +11 reference voltage.

   b. Drives ZA12 pin 11 positive.

   c. Triggers already enabled ZA13 gate 3, which in turn enables ZB1 gate 3.

The next KUT pulse triggers ZB1 gate 3, the output of which is inverted and applied through terminal TK UP to the Autorange and Display Driver.

If counters ZA8 through ZA12 are set and the input signal decreases in amplitude instead of continuing to increase, KDT pulses are generated. The first KDT pulse resets ZA12. The decade is now in a 9 count. When ZA12 reset, the negative output of pin 6 disabled the outputs of terminal $\overline{OR}$ and TK UP. The positive output of pin 9 enabled ZA14 gate 11.

The next KDT pulse triggers ZA14 gate 11 and results in resetting ZA8. The decade is now in an 8 count. Whenever the decade is in a 2, 4, 6, or 8 count, counter ZA8 is reset and ZA9, ZA10, and ZA11 are set. When either ZA9 or ZA10 is set, their pin 9 negative output is applied to ZC13 gate 11. The resultant positive output of the gate enables ZC13 gate 3. The next KDT pulse resets ZA9, ZA10, and, if in an 8 count, ZA11. Also, through ZC13 gate 3, the KDT sets ZA8. The decade is then in a 1 count. The next KDT resets ZA8 and the decade is in a zero count.

When ZA8, ZA9, and ZA10 are reset, their pin 9 outputs are applied through ZC9 gate 8 and terminal $\overline{TK0}$ to the Units Decade and Control Logic and Autorange.

UNITS, TENS, AND HUNDREDS DECODERS (DIAGRAM 16)

When the DMM is in a positive polarity configuration and the decades are all in a zero count, the 1-2-4-2* weighted resistors in the decoder assemblies are connected to the −11 reference voltage. As the input signal increases in positive amplitude, the resistors are successively switched to the +11 reference voltage. When the DMM is in a negative polarity configuration and the decades in a zero count, the resistors are connected to the +11 reference voltage. They are successively switched to the −11 reference voltage as the input signal increases in negative amplitude.

The switching action of each decoder is identical. Assume that the Units Decade has counted up to 7 when the DMM is in a positive polarity configuration. Terminals $\overline{U1}$, $\overline{U2}$, and $\overline{U4}$ are positive and resistors R65, R64, and R63 have been successively switched to +11 volts. The Units Decade has not yet counted to 9. Terminal $\overline{U2^*}$ is in a zero voltage state and transistors Q1, Q13, and Q25 are turned off. Transistor Q37 is conducting and resistor R62 is connected to the −11 reference voltage.

When the Units Decade counts to 9, terminal $\overline{U2^*}$ goes positive and Q1 is turned on, which turns-on Q13. With Q13 conducting, Q37 is turned off and Q25 turned on. Resistor R62 is now switched to the +11 reference voltage.

The output of the assembly is connected through terminal UTH OUTPUT to the One Thousand Decoder.

ONE THOUSAND AND TEN THOUSAND DECODERS (DIAGRAMS 17 AND 18)

Switching operation of the One Thousand and Ten Thousands Decoders is identical. The One Thousand Decoder switches the 1-2-4-2* weighted resistors in the thousands section of the resistance ladder. The Ten Thousands Decoder switches the 1-2-4-2* weighted resistors in the ten thousands section of the resistance ladder and also switches the overrange resistor and the polarity switch resistor.

On diagram 17 the input at terminal UTH is received from the Hundreds Decoder. Inputs to terminals $\overline{K1}$, $\overline{K2}$, $\overline{K4}$, and $\overline{K2^*}$ are received from the One Thousand Decade. The output at terminal 1K OUTPUT is applied to the Ten Thousands Decoder.

On diagram 18 the inputs to terminals $\overline{TK1}$, $\overline{TK2}$, $\overline{TK4}$, $\overline{TK2^*}$ and $\overline{O.R.}$ are received from the Ten Thousands Decade. The input to terminal POL SW DR is received from the Units Decade and Control Logic Assembly. The output at terminal DECODER OUTPUT

is applied to the summing junction at the input to the Comparator and Reference Amplifier.

When the DMM is in a positive polarity configuration and the Ten Thousands Decade is in a zero count, the 1-2-4-2* weighted resistors in the decoder are switched to the –11 reference voltage and the polarity resistor is switched to the +11 reference voltage.

Assume that the Units Decade and Control Logic is in a positive configuration and the Ten Thousands Decade is in a 7 count. Terminals POL SW DR, $\overline{TK1}$, $\overline{TK2}$, and $\overline{TK4}$ are all positive and $\overline{TK2}$* is negative. Transistors Q1, Q8, Q15, and Q29 are turned off. Transistors Q22 and Q36 are conducting and the 2* weighted resistor R6 is switched to –11 volts. When the Ten Thousands Decade counts to 9, terminal $\overline{TK2}$* goes positive. Transistor Q1 conducts and turns-on Q8, which turns on Q15. When Q15 conducts, Q22 and Q36 are turned off and Q29 turned on. Resistor R6 is now switched to the +11 reference voltage.

In the polarity switch section, potentiometers R44 and R80 are operational adjustments accessible through the top shield. The setting of R44 determines the amount of current flow at the junction of Q35 and Q42 when Q14 and Q35 are turned on. The setting of R80 determines the amount of current flow when Q28 and Q42 are turned on.

When the Ten Thousands Decade counts to 10 in an overrange condition, terminal $\overline{O.R.}$ goes positive and overrange resistors R2A and R2B are switched to the +11 reference voltage.

On diagram 17, resistors R8A through R12B and on diagram 18, resistors R1A through R7B and R13 are part of a ratio-matched set. One other resistor in the set is located in the Comparator.

AUTORANGE (DIAGRAM 19)

The Autorange Assembly is comprised of a range delay section, a range control counter section, and a FUNCTION control counter section.

When the DMM is in local control with the RANGE AUTO switch depressed, or when in remote control and autoranging is programmed, the assembly controls up and down ranging automatically in all functions.

Range Counter and Control

The autorange counter consists of Z13, Z14, and Z15. When power is first applied start circuit Q1 and Z17 forces the counter to the 1V range through diodes CR1, CR2, and CR3. The counter is now controlled by lines TKØ, TK UP, and CLOCK. A logic 1 on the TK UP line advances the counter one step to the next range. The Range Counter State Table on diagram 19 shows the status of lines QR3, $\overline{QR3}$, RA, RB, and RC for the various ranges.

If manual range changing is selected a logic zero appears on the auto line which blocks the clock from reaching the counter through gate 12 of Z19. Range changing is now performed by pulsing $\overline{MAN\ DN}$ and $\overline{MAN\ UP}$ lines. Each pulse advances the counter to the next state and the instrument to the next range.

When the DMM is in remote control, the range counter is controlled by lines RQR1 through RQR4. RQR4 acts as a strobe input. RQR1 through RQR3 force the range counter to a state by activating the direct set and clear inputs of the counter flip-flops.

A logic "1" on the MI line inhibits the counter from going to the 10 and 100 MV ranges when the HIΩ-MV Converter Assembly is not installed.

When the DMM was turned on the start circuit set the range counter to the 1V range through diodes CR1, CR2, and CR3.

The up/down counter QR1 to QR3 is controlled by its J and K inputs. Gates Z1 and Z3 established the correct signals at the J and K terminals. These signals tell the counter flip-flops which condition to go to on the next clock pulse. Pulses appearing at gate 11 of Z10 causes the counter to up range. Pulses appearing Z6 gate 8 cause the counter to down range.

The following is a description of events when the DMM is in the DC volts function and the input signals increases from 0.5 volt to 1000 volts and then decreases to 0.5 volts.

1. The counter is in the 000 state. Output lines $\overline{QR3}$ and RA are at a logic "1" level.

2. A positive pulse is received at terminal TK UP and is inverted by enabled gate 6 of Z1.

3. The pulse passes through Z10 gate 11 to Z9 pin 4.

4. Z9 inverts the pulse, passes it through C5 to Z17.

5. Z19 produces a positive output pulse which starts the range delay circuit and strobes the clock line of the range counter.

6. The counter now advances to the 100 state or the 10V range.

7. The range delay circuit blocks any more clock pulses from reaching the counter through gates 6 and 8 of Z19.

8. The DMM is now in the 10-volt range. The DMM is still overranged by the 1000 volt input and pulses are still appearing on the TK up line.

9. After the range delay circuit times out gates 6 and 8 of Z9 are enabled and the next TK UP pulse triggers the range delay circuit and advances the counter to the 001 state or the 100-volt range.

10. The DMM is in the 100 volt range but cannot null. At the end of the range delay time another pulse passes through Z9 gate 6, triggers the range delay circuit and advances the counter to the 110 state or the 1000-volt range.

11. The DMM is now able to null and no pulses will be present on the TK UP line. After the range delay time gates 6 and 8 of Z9 are enabled, but no pulses are present so the counter remains in the 110 state.

12. As the input signal falls back to 0.5 volt, it is tracked by the triquinary counter. When the ten thousands decade gets set to a "0", a zero level appears at terminal TKØ.

13. Gate 12 of Z19 is now enabled and clock pulses pass through Z19 gate 12 to pin 10 of Z6.

14. Gate 8 of Z10 inverts the pulses and they pass through to enabled gate 8 of Z9.

15. Z9 gate 8 inverts the pulses and they pass through C5 and Z17 gate where they are again inverted.

16. The positive going pulse at Z17 gate 6 triggers the range delay circuit and strobes the range counter.

17. The pulse at gate 8 of Z6 is also applied to pin 4 of Z1 and pin 13 of Z3. These gates establish proper levels on the J and K inputs so that the range counter counts down.

18. When the counter is strobed by the pulse from Z17 gate 6 it down ranges to the 110 state. Gates 6 and 8 of Z9 block any more pulses from strobing the counter.

19. The counter is now in the 100-volt range but a 0 is still stored in the ten thousands decade. When the range delay time runs out gates 6 and 8 of Z9 are enabled and the counter down ranges to the 100 state.

20. The DMM is now in the 10-volt range with a zero in the Tens thousands decade. At the end of the range delay time one more down range pulse will pass through gate 8 of Z9 and down range the counter to the 000 state.

21. The counter is now in the 1-volt range with a five stored in the ten thousands decade. This condition disables Z19 gate 12 and no more clock pulses pass through to the counter. The counter now remains in the one volt range.

Range Delay Section

Part of the range delay circuit is shown on diagram 20.

When a range change is made in the autoranging mode delays are introduced by the Range Delay circuit to allow the Input Amplifier and Filter to settle prior to the next range change. This delay ensures that the DMM does not make a false range change. The delay time is a function of the Input Amplifier settling time and the degree of filtering being used. The delay is controlled by the time constant of R13 and capacitors C4, C5, C6, and C7 on Diagram 20.

Whenever an up or down drive pulse is generated, Z29 is set and the $\overline{\text{DELAY GATE}}$ line goes low. This causes gates 6 and 8 of Z9 to be disabled and block any clock pulses from reaching the autorange counter and changing ranges, and turns off transistor Q3 and starts the delay timing cycle.

The delay timing cycle starts when Q3 turns off and C5 starts to charge through R13. When the firing potential of unijunction transistor Q2 is reached C5 discharges through R11 which produces a positive pulse at the base of Q1. Q1 now turns on and $\overline{\text{RG RESET}}$ goes to a logic zero. The $\overline{\text{RG RESET}}$ pulse resets Z29 which enables gates 6 and 8 and ends the timing cycle.

Relays K1 and K2 switch capacitors C6 and C7 in parallel with C5 when Med and Full Filter are selected. Q4 switches in C4 whenever any of the converters in the DMM are being used. This additional delay allows the converter time to settle.

Function Counter & Control

The function counter is a four state binary up counter consisting of Z21 and Z22. Its four states are decoded by Z20 and appear on lines AC, $\overline{\text{AC}}$, HIΩ, $\overline{\text{HIΩ}}$, LOΩ $\overline{\text{LOΩ}}$. These lines control relays in the Input Selector which connect the appropriate converter into the circuit. The counter is advanced to the next state each time the $\overline{\text{MAN FUNC STEP}}$ line is pulsed. When the DMM is in remote control lines RF, $\overline{\text{RQF1}}$, and $\overline{\text{RQF2}}$ control the counter directly through the set and clear inputs of Z21 and Z22.

Range and Function Indicator Control

Z3, Z4, Z5, and Z6 decode the state of the range counter and provide logic-level signals on lines MVL, MΩL, KΩK, and ΩL. These lines control the range indicator lamps on the front panel of the DMM. Only one of the lamps can be on at any time since the counter can only be in one state at a time.

Lines $\overline{\text{HIΩLC}}$, $\overline{\text{LOΩLC}}$, and $\overline{\text{ACLC}}$ provide a logic zero to gates 8, 6, and 12 of Z23 whenever the HIΩ-MV, LOΩ, or AC converters are installed. These inputs force the outputs of the gates to a logic one which then lights the indicator lamps through lines DCL, ACL, HIΩL and LOΩL. Z12 is connected as a low frequency oscillator which is fed to an input of gates 6, 8, and 12 of Z23. If a function is selected but the converter is not installed the low frequency oscillator signal will pass through the enabled gate and cause the function indicator lamp to blink indicating that the converter is not installed.

FUNCTION DECIMAL (DIAGRAM 20)

The Function Decimal Assembly receives information from the front panel switches, the function counter, the range counter, and various other assemblies. The information is decoded and routed to other assemblies to enable:

1. Special purpose control of Ratio function and decimal location.
2. Selection of printout and front panel readout decimal location.
3. Control of Signal AC Converter range.
4. Control of DMM sensitivity.
5. Range delay timing control.

Special Purpose Control of Ratio Function and Decimal Location

Terminals $\overline{\text{MRR1}}$ to $\overline{\text{MRR4}}$ are controlled by the external reference range switches on the front panel.

These lines are decoded by Z20, Z1, Z2, Z3, Z4, Z5, Z6, Z8, Z14, Z15, Z16, and Z22 and control the decimal point location through lines KD1A, KD1B, KD2, KD3, and KD4 when the DMM is in the ratio mode. A "0" level on terminal $\overline{\text{RATIO RGE}}$ causes the decimal point to move to the left one digit in the readout display when the ratio mode is selected. A zero on the $\overline{\text{DEC INHIBIT}}$ line disables decoder gates of Z1, Z2, Z3, Z5, Z6, and Z7, which blanks out all the decimal points in the readout display. Whenever the decimals are blanked by the $\overline{\text{DEC INHIBIT}}$ line they may be individually controlled by lines $\overline{\text{RKDØ}}$, $\overline{\text{RKD1}}$, $\overline{\text{RKD2}}$, $\overline{\text{RKD3}}$, and $\overline{\text{RKD4}}$ from the Remote.

Selection of Printout and Front Panel Readout Decimal Location

Input lines QR3, $\overline{\text{QR3}}$, RA, RB, and RC bring range information into the decoder GATES while lines AC,

$\overline{LO\Omega}$, and $\overline{HI\Omega}$ bring function information into the decoder gates. The decoder processes the information and provides an output on lines KD1A to KD4 which indicate where the decimal point should be placed in the front panel readout display. The output lines also supply the decimal point location information to the Print assemblies.

Control of Signal AC Converter Range

Input signals from the range counter are decoded by gates 6, 8, and 12 of Z19 which is enabled by the AC line, and fed to terminals CR2, CR3, and CR4. These lines control the input attenuator of the Signal AC Converter.

Control of DMM Sensitivity

When the front panel SENSITIVITY X2 switch is depressed, terminal $\overline{SX2}$ goes low. This signal is inverted by Z13 gate 8 and Z22 gate 6. The output of Z22 gate 6 is the $\overline{S2*}$ line which controls the gain of the comparator amplifier. When the SENSITIVITY 4 switch is pressed terminal $\overline{S4*}$ goes low which changes the gain of the comparator amplifier the equivalent of 400 μ volts.

With the jumpers to the input of Z13 gate 6 installed as shown in diagram 20, the DMM is automatically desensitized four digits when:

1. The DMM is in the AC function and not in full filter.

2. When the DMM is in the 10 MV range and not in medium or full filter.

The dotted jumper connection are for special applications.

Range Delay Timing Control

The range delay timing control circuit comprises K1, K2, Q2, Q3, Q4, C4, C5, C6, C7, and R13. Its operation is discussed under the Autorange Assembly description.

DISPLAY DRIVER (DIAGRAM 21)

The Display Driver Assembly enables illumination of front panel function indicators, polarity indicators, and the units window through overrange window numerals and decimals.

Signals from the Units through Ten Thousands Decades are received at terminals UL, TL, HL, KL, and TKL, to illuminate the associated window numerals. When the ten thousands window decoder ZB1 is driven by binary coded signals at terminal 1, 2, 4, and 8 it drives the 1 through 9 numerals in DS3. If none of the inputs are positive, the zero indicator is illuminated. Operation of the other window decoders is identical.

Signals from the Autorange Assembly are received at terminal:

1. $\overline{SIGN\ INHIBIT}$ to disable the polarity indicator when the DMM is in AC, KΩ, AC/AC, or DC/AC modes of operation.

2. RF, MΩL, KΩL, ΩL, and MVL which turn on Q10 through Q6 to activate the range indicator lamps on the front panel.

3. RATIO L, DCL, ACL, HIΩL, and LOΩL which turn on Q1 through Q5 to activate the function indicator lamps on the front panel.

Signals from the Function Decimal Assembly are received at terminals KOR, KD$\emptyset$, KD1A, KD1B, KD2, KD3, and KD4 which activate the decimal points through transistors Q13, Q15, Q16, Q18, Q19, Q20, Q21, and Q22.

KD$\emptyset$ illuminates the left hand decimal point of DS2 whenever the DMM is in the ratio mode. In all other modes KD1A illuminates the right hand decimal of DS1 if a 1 or a zero is displayed. If the overrange window is blank, KD1B illuminates the decimal. This arrangement maintains the decimal point at equal brilliancy regardless of the presence of a 1 or a zero in the window of DS1. KD2, KD3, and KD4 illuminate the decimals in the ten thousands through the hundreds window respectively.

Terminal KOR indicates an overrange condition and lights the 1 in the overrange window. If the DMM is out of range the overrange 1 will be illuminated by KOR. Terminal TK UP will go high indicating that the input signal is out of range. When TK UP goes high Q17 turns on, Q14 turns off and Z2 gate 8 is enabled. Z2 gates 6 and 8 form a 1-second oscillator which starts to run when Z2 gate 8 is enabled. The output of this oscillator is "ANDed" with the KOR signal by Z1 gates 8 and 11. The overrange 1 now blinks at a one second interval indicating an out of range condition. If the DMM was overranged in the ratio mode on the 1-volt range the alternate positive-zero output level of Z1 gate 11 would be combined with Z1 gate 3 to cause a 1 and a zero to alternately appear in the overrange window.

Terminals +POL and –POL are connected to the Units Decade and Control Logic Assembly. When the DMM is in the positive polarity configuration terminal +POL is positive and the + indicator is illuminated. In the negative polarity configuration, terminal –POL is positive and the – indicator is illuminated.

When the DMM is in the ratio function terminal $\overline{\text{–REF POL}}$ indicates the polarity of the external reference voltage. Z3 receives polarity information and provides output signals to DS1 indicating the algebraic sum of the signs of the input signal polarity and the reference signal polarity.

The $\overline{\text{SIGN INHIBIT}}$ terminal from the Autorange Assembly blanks out the polarity information through diodes CR4 and CR5 when the DMM is in the AC, KΩ, AC/AC, or DC/AC ratio modes.

PRINT CONTROL (DIAGRAM 22)

The Print Control Assembly is comprised of the following sections:

1. Ready-Enable
2. Null Detection
3. Delay
4. Print Command
5. Desensitize
6. Reference Voltage Power Supply

Prior to a printout the Print Control Assembly:

1. Disables up or down pulses from the Comparator to the Units Decade and Control Logic Assembly.
2. When commanded by a Remote Control Unit, desensitizes itself and furnishes the desense information to Print Output No. 1 for printout.
3. Enables the Print Outputs for printout.
4. Issues a print command through Print Output No. 1 to an external recording device.

The Print Control input terminals receive information from the sources listed in table 5-3.

Table 5-3. Print Control Assembly Input Sources.

TERMINAL	SOURCE
TUT and TDT	10s and 100s Decade Assembly
UUT, UDT, UP, DN, RMPE, $\overline{\text{FP}}$, $\overline{\text{REP MODE}}$	Units Decade and Control Logic Assembly
$\overline{\text{MV}}$, $\overline{\text{KΩ}}$, $\overline{\text{AC}}$, $\overline{\text{FF}}$, $\overline{\text{MF}}$, $\overline{\text{REBAL}}$, $\overline{\text{HOLD}}$, $\overline{\text{AUTO PRT}}$	Front Panel Switches or Remote Assembly
$\overline{\text{READY}}$	External Recording Device
$\overline{\text{DESENSE}}$	Remote Assembly
$\overline{\text{PRT RNG}}$	Autorange Assembly

Ready Enable Section

Except when in the REPETITIVE MODE of operation or when a FORCE PRINT has been commanded, a READY signal is required to enable the Print Command section. The signal is applied through jumper connections A-B-C-D-E-L. Jumper connections:

1. A-D provides a path for immediate application of an internally generated Ready signal.

2. A-B provide for a delay of about 20 milliseconds in applying the Ready signal. The delay enables an external recording device to recycle prior to receiving the next print command. The values of C3 and R15 determine the amount of delay. Table 5-4 lists the values of C3 to attain various Ready signal delay times.

Table 5-4. Values of C3 for Various Ready Signal Delay Times.

C3 VALUE	APPROXIMATE DELAY TIME
100 pF	10 μsec max.
1 nF	100 μsec max.
10 nF	1 msec max.
100 nF	10 msec max.
1 μF	100 msec max.
10 μF	1 sec max.

3. A-C or A-E provide a path for an externally generated Ready signal. The signal is originated by an external recording device when it is ready to receive a print command. The signal is routed through Print Output Assembly No. 1 and terminal $\overline{\text{READY}}$. If the Ready pulse is normally positive-going, the jumper connection must be A-C. The leading edge of the pulse keeps Z1 gate 6 disabled until the recording cycle has been completed. If the Ready pulse is normally negative-going, the pulse is inverted at Z16 inverter 6 and must be connected through jumper connection A-E.

4. A-L allows the print COMMAND circuitry to be enabled without a $\overline{\text{READY}}$ input from an external source in any mode except hold. In the hold mode point A is held at a zero level. When the $\overline{\text{REB}}$ input is strobed it is routed through Z27 and Z28 to point A which enables the print command circuitry.

While a print command is being issued, terminal $\overline{\text{PRT COMMAND}}$ and the output of Z4 gate 8 are at zero voltage state. If an internal Ready signal is desired the voltage state is applied to Z2 pins 13 and 10 through A-D, or through Z8 pin 1, transistor Q9, and A-B. The resultant momentary zero-state output of Z1 inverter 8 resets flip-flops Z17, Z10, Z5, and Z6. Print Clamp, Print Gate, and Print Command can now be issued as soon as all other conditions have been established. A Ready signal received at terminal $\overline{\text{READY}}$ has the same effect.

When power is first applied, Print Gate-Print Command flip-flop Z17 and Print Clamp flip-flop Z10 may not be in the proper state to enable operation. When power is applied, transistor Q11 is momentarily held off until C9 charges. During the time Q11 is off, a zero voltage state is applied to Z1 pin 12. A Ready signal is generated that resets flip-flops Z17 and Z10.

Null Detection Section

Up or down pulses are received at terminals UP or DN and applied through Z22 gate 2 to Z22 gate 11. If the desense section has not been commanded to desensitize, Z22 gate 11 is triggered. The zero-voltage state pulse output of the gate is applied to Z7 pins 12 and 10 and Z15 pin 12. The leading edge of the pulse, through Z15 pin 12, sets flip-flop Z14. The trailing edge, through Z7, resets the flip-flop. As long as UP or DN pulses are present Z14 is continuously set and reset. When Z14 is set the positive state output of pin 3 is applied to Z14 pin 10. When the assembly is not in the desensitize 3 mode, Z14 pin 9 is positive. The resultant zero voltage state output of Z14 gate 9 is applied to Z20 pin 13. If the instrument is not in the repetitive mode of operation and is in either PRINT AUTO or HOLD, Z20 pin 2 is positive. The resultant positive voltage state of Z20 gate 12 turns transistor Q16 on. When flip-flop Z14 is reset, Z20 pin 13 goes positive. The resultant zero voltage state of Z20 gate 12 turns Q16 off. Q16 on and the trailing edge turns Q16 off. When a Print Command is issued, flip-flop Z14 is set through Z15 pin 13. Transistor Q16 is turned on and remains on until UP and DN pulses are again applied. When UP or DN pulses are present C16 is not permitted time to charge to the firing potential of Q19. When a null occurs, C14 charges and fires Q19. The charge time of C14 is the delay time.

The C14 charge path, dependent on the degree of filtering selected, is as follows:

1. FILTER OFF–FET transistor Q14 is conducting and Q18 is turned off. The charge path is R30, R31, and Q14.

2. FILTER MEDIUM–Terminal $\overline{\text{MD}}$ goes false, turning Q17 off and Q18 on and Q15 on and Q14 off. The path is R30, R31, R29, and R34 and Q18.

3. FILTER FULL–Terminal $\overline{\text{MD}}$ goes true, turning Q17 on and Q18 off. Terminal FFD goes false, turning Q15 on and Q14 off. The path is R30, R31, and R29.

Potentiometer R30 is an operational adjustment that is accessible through the top shield and can be varied to adjust the delay from about 5 milliseconds to about 50 milliseconds.

Print Command Section

When C14 discharges through Q19 and R18, Q20 is turned on and flip-flop Z17 is set.

When Z17 is set:

1. Pin 12 goes positive and issues either a PRINT GATE command through jumper connections H-F or a $\overline{\text{PRINT GATE}}$ command through connection G-F. The command is applied through terminal PRT GATE to Print Output No. 1 and enables the Print Outputs.

2. Pin 6 goes false and:

   a. Through Z10 pin 9 issues a PRINT CLAMP command. The command is applied through terminal $\overline{\text{PRT CLAMP}}$ to the Units Decade and Control Logic to disable UP and DN pulses from the Comparator. The information in the Decades cannot be changed and is ready for printout.

   b. Through Z4 pins 13 and 1 provide a PRINT COMMAND to the external recorder via terminal $\overline{\text{PRT COMMAND}}$ and Print Output No. 1. Capacitor C22 delays the leading edge of the Print Command pulse so that it lags the PRINT CLAMP command by about one millisecond. The PRINT COMMAND pulse width, controlled by C23 is about one millisecond. If it is desired to vary the PRINT COMMAND pulse width, the value of C23 must be changed. A pulse width increase of about one millisecond can be added for each one microfarad increase in the value of C23.

   c. Through Z15 pin 13 sets flip-flop Z14 and turns on transistor Q16.

When the DMM is placed in PRINT AUTO mode terminal $\overline{\text{AUTO PRT}}$ goes false. The false condition is inverted at Z19 inverter 11 and applied to Z3 gate 8 to enable that gate if the DMM is placed in Repetitive mode. The output of the terminal is also applied to Z19 gate 8 and is applied as a positive voltage to enable Z20 gate 12.

When the DMM is placed in the PRINT HOLD mode, terminal $\overline{\text{HOLD}}$ goes false. This state is applied through Z19 pin 9 to enable Z20 gate 12 for a REBALANCE printout. The false state is also applied through Z18 inverter 6 to Z18 gate 3, to enable that gate for a REBALANCE printout, and to Z10 pin 5. When the previous PRINT COMMAND was issued, flip-flop Z10 was reset by the Ready signal and Z10 pin 4 went true. When Z10 pin 5 goes true, the gate is triggered and a $\overline{\text{PRINT CLAMP}}$ command is issued and maintained as long as the DMM is in the HOLD mode.

While in the HOLD mode, if PRINT REBAL switch is depressed terminal $\overline{\text{REBAL}}$ goes false and Z18 gate 3 is triggered. Triggering is delayed by C19 until any noise generated by the REBALANCE momentary contact switch has dissipated. The output of Z18 gate 3 triggers Z11 gate 11. The width of the zero voltage state pulse output of Z11 gate 11 is about 30 microseconds and is controlled by C20.

The Z11 gate 11 output is applied to Z7 pin 13 to generate a false drive pulse if the instrument is in a null, and resets flip-flop, Z14. The output also sets flip-flop Z10 which removes the PRINT CLAMP command. The DMM makes a measurement, issues a PRINT COMMAND and then returns to the HOLD mode.

When the DMM is in PRINT TRACK, AUTO, or HOLD mode and the PRINT FORCE switch is depressed, terminal FP goes false. Capacitor C17 delays the pulse until switch-action noise is dissipated. The pulse sets flip-flop Z17 which causes PRINT GATE, PRINT CLAMP and PRINT COMMAND to be issued. The commands are issued whether the DMM has nulled or not nulled.

In Repetitive Mode operation terminal $\overline{\text{REP MODE}}$ goes false. This condition is applied through Z19 to Z20 pin 2 and transistor Q16 is maintained in an on condition. The Print Delay and Desense sections are disabled and the Print Command section can function only when a Repetitive Mode Print Enable command is present.

When the Units Decade and Control Logic generates a Repetitive Mode Print Enable command, the positive voltage state pulse is applied through terminal RMPE to Z3 pins 5 and 9. Pulse generators 3 gate 8 and Z9 gate 8 are triggered and flip-flop Z17 is set, which causes PRINT GATE, PRINT CLAMP, and PRINT COMMAND to be issued. The commands are issued whether the DMM has nulled or not nulled. The Print Command section is again disabled until receipt of the next RMPE command.

Desensitize Section

Desensitizing is not to be confused with instrument sensitivity described elsewhere in Section V. When Desense is programmed the Desense circuitry scans the UP or DN pulses that are the input to the Units Decade. If, because of noise on the input signal, the instrument cannot null the Desense circuitry then shifts to scan the UUT or UDT pulses that are the input to the Tens Decade. Again, if there is no null the circuitry shifts to scan the TUT or TDT pulses that are the input to the Hundreds Decade. At this point if there is no null the circuitry forces a printout. The degree of desensitizing is indicated in the printout.

Desensitizing is normally programmed from a Remote Control Unit and cannot be programmed from the DMM front panel. If desensitizing is desired and a Remote Control Unit is not available, jumper connection K-J can be made on the Print Control Assembly. Once the jumper connection is made the Print Control will remain in the Desensitizing mode until the jumper is removed.

When Desensitizing is not programmed, terminal $\overline{\text{DESENSE}}$ is true. This state keeps flip-flop Z21 in a reset condition and Q1 turned on, shorting out desense delay capacitor C1.

The scan time is determined by the charge paths of capacitor C1, which are as follows:

1. In V or Ratio mode and no filtering—transistors Q5 and Q6 are conducting and Q7 is turned off. The path is Q5, Q6, and R2.

2. In MV, KΩ, or AC mode and no filtering—Q5 is conducting and Q6 and Q7 are turned off. The path is R6, Q5, and R2.

3. Medium filter in V or Ratio mode—Q6 and Q7 are conducting and Q5 is turned off. The path is Q6 and R5, Q7 and R7, and R2.

4. Medium filter in MV, KΩ, or AC mode—Q7 is conducting and Q5 and Q6 are turned off. The path is R5 and R6, Q7 and R7, and R2.

5. Full filter in V or Ratio mode—Q6 is conducting and Q5 and Q7 are turned off. The path is Q6, R5, and R2.

6. Full filter in MV, KΩ, or AC mode—Q5, Q6, and Q7 are turned off. The path is R6, R5, and R2.

When Desensitize is programmed, terminal $\overline{\text{DESENSE}}$ goes false. This state is inverted at Z21 inverter 8, Z20 gate 8, and Z20 inverter 6. The positive output of Z20 inverter 6 removes the reset clamp from flip-flop Z21. The positive output of Z21 inverter 8 is also applied to and enables Z21 gate 6.

When either an up or down pulse is received at terminal UP or DN, the output of Z22 gate 3 is positive and enables Z22 gate 11. When Z5 and Z6 are reset, pin 9 is true. The pin 9 outputs are inverted at Z12 gate 11. The output of gate 11 is applied through terminal $\overline{\text{DSP}\emptyset}$ to Print Output No. 1 for printout when a print command is issued. The output at terminal $\overline{\text{DSP}\emptyset}$ indicates no desensitizing has occurred and that the printout is valid. The Z12 gate 11 output is also inverted at Z12 inverter 8 and triggers Z22 gate 11.

When Z22 gate 11 goes false, flip-flop Z21 sets and turns off Q1. Capacitor C1 starts charging.

The output of Z22 gate 11 is also applied to the null detector Z7 pins 12 and 10 and Z15 pin 12. When the up or down pulses cease the null detector initiates the signal that produces a PRINT COMMAND. When the PRINT COMMAND is issued, the zero voltage state is applied to Z20 pin 9 and inverted twice at Z20 gate 8 and Z20 inverter 6. The false output of inverter 6 holds Z5 and Z6 in the reset state and resets flip-flop Z21. Transistor Q1 is turned on and C1 is shorted before it has charged to the firing potential of Q2.

If the up or down pulses do not stop and a null cannot be detected, a PRINT COMMAND will not be issued. Capacitor C1 discharges through Q2 and momentarily turns on Q3. The output of Q3 sets Z5. The Z5 pin 6 and Z6 pin 9 positive outputs are now applied through Z12 gate 3 to trigger Z23 gate 11. The input to the Tens Decade is now being scanned.

Again, if a null cannot be detected C1 discharges and Z5 is reset and Z6 is set. The input to the Hundreds Decade is scanned. If there is no null, both Z6 and Z5 are set. The pin 6 outputs trigger Z13 gate 6. The output of gate 6 triggers Z14 gate 8 through pulse generator Z25 and flip-flop Z26 and forces a printout. When the print command signal goes low, Z26 is reset which enables Z14 gate 8. The output of Z14 gate 8 disables Z20 gate 12 and holds Q16 on. The output of gate 6 also applies a Desensitize Position 3 signal to Print Output No. 1. The PRINT COMMAND resets Z6, Z5, and flip-flop Z21 for the next cycle.

When the DMM is in AUTORANGE, each time a range change commences terminal $\overline{\text{PRT RNG}}$ goes false. This condition resets flip-flop Z21 and turns on transistor Q3. The desensitizing circuit restarts timing and a printout cannot be forced during the range change.

Reference Voltage Power Supply

A 12-volt power supply is mounted on the Print Control Assembly but is not electrically connected to the DMM guard shield. The power supply furnishes up to ±12 volts to either the voltage state or buffered print output assemblies as reference voltage and to the relay coils of the Remote Buffer Assembly. The value of the reference voltage can be reduced to any desired value less than 12 volts by changing resistor R14. Figure 6-3 lists jumper connections that must be made on the power supply and Print Output Assemblies to accommodate the type of logic used.

BCD PRINT OUTPUTS (DIAGRAMS 23 THROUGH 34)

There are four optional types of 1-2-4-8 BCD Print Outputs available. They are:

1. Plus 5 to zero diode-transistor logic (DTL) voltage state.
2. Plus 12 to zero voltage state.
3. Minus 12 to zero voltage state.
4. Contact closure.

The BCD Print Output Assemblies provide the DMM function information and all the measurement information contained in the DMM front panel readout. In addition they provide the degree of DMM sensitivity that has been selected and the extent of desensitizing performed by the Print Control. The information is provided to an external recorder together with a Print Command originated by the Print Control.

A Ready signal originated by an external recorder is transferred by Print Output No. 1 to the Print Control.

Connectors J2, J3, and J4 shown on the diagram are an integral part of the assemblies and protrude through the DMM rear panel.

The DTL Print Output No. 1, No. 2 and No. 3 Assembly (diagrams 23, 24, and 25) outputs through J2, J3, and J4, respecitvely, are +5 volts for true and zero volts for false. The maximum current output is 5 milliamperes.

The BCD Print Output Assemblies receive information from the sources listed in table 5-5.

The assemblies may be operated with or without a Print Control Assembly in the DMM. With no Print Control Assembly:

Table 5-5. Input Sources to BCD and Ten-Line Print Output Assemblies.

TERMINAL	SOURCE
ASSEMBLY NO. 1	
$\overline{\text{MRR1}}$, $\overline{\text{MRR2}}$, $\overline{\text{MRR3}}$, $\overline{\text{MRR4}}$, $\overline{\text{AC/AC RATIO}}$, $\overline{\text{DC RATIO}}$, $\overline{\text{MFD}}$, $\overline{\text{FFD}}$, $\overline{\text{S4}}$, $\overline{\text{S16}}$, $\overline{\text{SX2}}$, $\overline{\text{S1}}$	Front Panel Switches or Remote
KD1, KD2, KD3, KD4	Auto Range
A, B	Print Assy. No. 3
+POL, –POL	U.D. & C.L.
REF POL	Ref Amp.
KOR	K & TK Decade
U1, U2, U4, U8	Units Decade
ASSEMBLY NO. 2	
TL1, TL2, TL4, TL8, HL1, HL2, HL4, HL8	T & H Decade
A, B	Print Assy. No. 3
ΩL, HIΩL, MVL, MΩL	Auto Range
ASSEMBLY NO. 3	
KL1, KL2, KL4, KL8, TK1, TK2, TK4, TK8	K & TK Decade
$\overline{\text{DSP1}}$, $\overline{\text{DSP2}}$, $\overline{\text{DSP3}}$, –PS, +PS, $\overline{\text{PC}}$, PRINT GATE	Print Control
ACL, HΩL, LOΩL	Auto Range
A, B REF VOLTAGE	Print Assy. No. 3

1. It is necessary to make a jumper connection on the Master Board between $\overline{\text{PRINT COMD}}$ and RMPE.

2. On DTL Print Output No. 1 Assembly:

   a. Jumper connection D-F must be made.

   b. Terminal $\overline{\text{READY}}$ and pin J4-40 and J4-41 are not used.

The BCD Voltage State Positive Reference Print Output Assemblies (diagrams 26, 27, and 28) provide an output of zero or +12 volts. Whether the zero state of +12-volt state is true depends on the A-B-C jumper connections on each assembly. With the solid connections shown on the diagrams, +12 volts is true and zero is false. If the dotted line connections were made, zero would be true.

When terminal $\overline{\text{PRINT GATE}}$ goes false relay K1 is energized and applies the reference voltage to the transistor output switches. The application of reference voltage can be maintained as long as desired by making jumper connections D-F.

When a $\overline{\text{READY}}$ signal is applied to J2-36, Q14 is turned on and applies a ground through terminal $\overline{\text{READY}}$ to the Print Control Assembly.

The BCD Voltage State Negative Reference Print Output Assemblies (diagrams 29, 30, and 31) provide an output of zero or –12 volts. Whether the zero state or the –12-volt state is true depends on the A-B-C jumper connections on each assembly. With the solid connections shown on the diagrams, –12 volts is true and zero is false. If the dotted line connections were made, zero would be true.

When terminal PRINT GATE goes true, relay K1 is energized and the reference voltage is applied to the transistor output switches. The application of reference voltage can be maintained as long as desired by making jumper connections D-F.

When a Ready signal is applied to J1-36, Q14 is turned on and applies a ground through terminal $\overline{\text{READY}}$ to the Print Control Assembly.

The BCD Buffered Print Output Assemblies (diagrams 32, 33, and 34) provide isolation between the DMM and the external recorder by means of relay contacts. Closed contacts represent a true state.

When terminal $\overline{\text{PRINT GATE}}$ goes false the state is inverted and triggers those relay driver gates that have been enabled.

If the unmarked jumpers on both assemblies are removed, the commons for the various outputs can be driven separately for serial operation.

TEN-LINE PRINT OUTPUT ASSEMBLIES (DIAGRAMS 35, 36, and 37)

The Ten-Line Print Output Assemblies provide the DMM function information and all the measurement information contained in the DMM front panel readout. In addition they provide the degree of DMM sensitivity that has been selected and the extent of desensitizing performed by the Print Control Assembly. The information is provided to an external recorder together with a Print Command originated by the Print Control Assembly.

A Ready signal from the external recorder is received at J4-10 and J4-9 and energizes relay K1, applying the Ready signal to the Print Control Assembly.

The Ten-Line Print Output Assemblies receive information from the sources listed in table 5-5.

On Assembly No. 3, either a + or – reference voltage is furnished to the external recorder through J4-23 and a common through J4-11.

If jumpers A-A, B-B, and C-C on assemblies 2 and 3, and D-D, E-E, F-F, and G-G on Assembly No. 1 are removed, the common for the various outputs can be driven separately for serial operation.

REMOTES (DIAGRAMS 38 and 39)

There are two Remote Assemblies, either one of which can be used in the DMM. On the diagrams, connector J1 is an integral part of the assembly and protrudes through the DMM rear panel for connection to a Remote Control Unit.

Remote Buffer (Diagram 38)

The Remote Buffer Assembly isolates the DMM and Remote Control Unit circuits from each other. Commands from the Remote Control Unit are received at connector J1 and energize relays on the Remote Buffer Assembly. The closed contacts of the relays duplicate the remote commands. The only exception to this is Relay K32. Relay K32 enables the 5 volt power to one side of the relay coils. If the $\overline{\text{SENSE REM COM}}$ line is low K32 is enabled and the DMM may be remotely controlled. If the $\overline{\text{SENSE REM COM}}$ line is high, the relays cannot be enabled and "lockout" of remote control data occurs. When K32 is energized relay K29 is enabled and provides a remote indication at J1-45.

At the option of the operator, +5 volts may be furnished from the Remote Control Unit through terminal J1-16 as coil supply for the Remote Buffer Assembly relays. In such case, jumper A-B must be changed to A-C.

Remote (Diagram 39)

The Remote Assembly provides non buffered remote control of the DMM with lockout protection. When the $\overline{\text{SENSE REM COM}}$ line is high Z16 gate 6 and Z16 gate 8 outputs are low which disables Z17, Z10, Z9, Z3, Z12, Z13, Z15, Z6, Z11, and Z17. When the $\overline{\text{SENSE REM COM}}$ line is low these gates are enabled and the DMM may now be remotely controlled.

Both Assemblies

On both assemblies:

1. Terminal DVM COM is continuously grounded on the Master Board.

2. When the DMM REMOTE CONTROL switch is depressed:

   a. Terminal $\overline{\text{S1}}$ which is wire "ORed" with the Autorange Assembly gains control.

   b. Terminals $\overline{\text{RKD0}}$, $\overline{\text{RKD1}}$, $\overline{\text{RKD2}}$, $\overline{\text{RKD3}}$, and $\overline{\text{RKD4}}$ which are wire "ORed" with the Function Decimal Assembly gain control.

   c. All remaining signal terminals which are wire "ORed" with the front panel switches gain control.

POWER SUPPLY (DIAGRAM 40)

The Power Supply Assembly supplies filtered and regulated +22, –22, +12, and +5 volts and filtered +230 volts to other assemblies as indicated in table 5-6.

The AC inputs to the assembly are taken from the secondary windings of power transformer T1. The +22 volt supply receives AC input at terminals A and B. The AC supply is rectified by bridge rectifier CR2 and filtered by C13. The rectified +22 volts is applied to control transistor Q3, and series pass transistor A1 Q2. The collector signal of control transistor Q3 controls the conduction of series pass transistor A1 Q2. Any change in output voltage is sensed by voltage regulator AR3 through the divider consisting of R24, R25 and R26. The output of AR3 is amplified by Q3 and applied to A1 Q2 as an error signal which changes its conduction and thus maintains the output at a constant voltage. The –22 volt and +5 volt supplies operate in a similar manner to the +22 volt supply.

The +12 volts is obtained from emitter follower Q4 which provides current amplification for zener diode CR4. Q5 and Q6 insure that the +5 volt supply is working before the +12 volt supply can be turned on. If the 5 volt supply is low, Q5 is turned off, Q6 is turned on which shorts CR4 and causes the +12 volts to be low. This insures all the supplies in the DMM are working before it can be remotely programmed or print out data. Potentiometers R14, R11, and R25 are accessible through the DMM top shield and are used to adjust the +5V, –22V and +22V supplies respectively.

MASTER SCHEMATIC DIAGRAM (DIAGRAM 41 SHEETS 1 AND 2)

The master schematic diagram shows the interconnections between the front and rear panel Reference and Signal input connectors, front panel switches, individual assemblies, and components mounted on the master circuit board. On all signal lines such as UL1, a solid dot indicates the assembly that generates the signal. An open dot indicates a connection. Some lines such as $\overline{\text{RKD1}}$ are observed to have two solid dots. This indicates a "wired OR" connection between the two assemblies. Either assembly can generate the signal. Lines that connect to the front panel switches generally are "wire ORed" with one of the assemblies. Rear panel connector J2 is an integral part of Print Output Assembly No. 1. Rear panel connector J3 is an integral part of Print Output Assembly No. 2. Rear panel connector J4 is an integral part of Print Output Assembly No. 3. Rear panel connector J1 is an integral part of either the Remote Buffer or Remote Control Assembly. For internal connection information pertaining to J4, J3, J2, or J1, refer to their associated assembly schematic diagrams in Section VI.

Table 5-6. Power Distribution.

TO ASSEMBLY	+22	–22	+5	+230	+12
Input Selector			X		X
HIΩ-MV Converter	X	X	X		
AC Converters	X	X	X		
LOΩ Converter			X		
Input Amplifier	X	X	X		X
100 MΩ Converter	X	X			
Reference Amplifier	X	X	X		X
Comparator	X	X	X		
Units Decade and Control Logic	X	X	X		
10s and 100s Decade			X		
1K and 10K Decade			X		
Units, 10s and 100s Decoder	X	X			
1K Decoder	X	X			
10K Decoder	X	X			
Autorange	X		X		
Function Decimal	X		X		
Display Driver			X	X	
Print Control	X		X		
Print Output No. 1			X		
Print Output No. 2			X		
Print Output No. 3			X		
Remote Buffer			X		
Remote Control			X		

SECTION VI

MAINTENANCE

GENERAL

Section VI contains operational adjustment procedures, troubleshooting and repair information, installation instructions for optional equipment ordered separately, parts lists, parts location diagrams, and schematic diagrams of each assembly and subassembly.

OPERATIONAL ADJUSTMENTS

NOTE

Prior to performing operational adjustments it is recommended that the General paragraphs of Troubleshooting be read for information on printed circuit board removal.

When calibrating the DMM, if the calibration controls (Section IV) cannot be adjusted to provide the correct front panel indication the operational adjustment procedures must be performed.

The following equipment is required to perform the operational adjustments:

1. Five-digit digital voltmeter (six digits in overrange). Cimron Model 6753 or equivalent (test DVM).
2. DC Voltage Calibrator, Fluke Model 332A or equivalent.
3. Voltage Divider, ESI Model RV722 or equivalent.
4. Oscilloscope, Tektronix Model 502A or equivalent.
5. Resistance Decade Box, 1%.
6. Insulated Alignment Tool.

PRELIMINARY PROCEDURE

Prior to performing the operational adjustments position the DMM front panel controls as follows:

CONTROL	POSITION
POWER	Off (Down)
REPETITIVE MODE	Off
SENSITIVITY 1	Depressed
SENSITIVITY X2	Unlatched
FILTER	As Required
RANGE AUTO	Depressed
FUNCTION MV/DC	Unlatched
FUNCTION INT LOK	Depressed
PRINT TRACK	Depressed
REMOTE CONTROL	Unlatched
REFERENCE INT	Depressed

Using the test DVM, connect the test setup shown in figure 4-2. The 6853 DMM connections are shown in figure 4-1.

POWER SUPPLY ASSEMBLY OUTPUT VOLTAGE

±22-Volt Outputs

To adjust the + and –22-volt outputs:

1. Perform the Preliminary Procedure except depress RANGE UP switch once to put DMM in 10-volt range.
2. Remove the top cover. Connect the test DVM between terminals –22 and COM (figure 4-1).
3. Position the DMM and test DVM POWER switches to on.
4. Vary the –22V ADJ control for a test DVM readout of –22.5V ±0.01 volt.
5. Connect the test DVM between terminals +22V and COM.

6. Vary the +22V ADJ control for a test DVM readout of +22.5V ±0.01 volt.

7. Repeat steps 4 and 6 until interaction between the adjustments no longer exists.

8. Position the DMM and test DVM POWER switches to off. Disconnect the test DVM. Replace the DMM top cover.

±5-Volt Output

To adjust the +5-volt output:

1. Perform the Preliminary Procedure except depress RANGE UP switch once to put DMM in 10-volt range.

2. Remove the top cover and shield.

3. Connect the test DVM between +5V and COM.

4. Vary +5V ADJ for a test DVM readout of +5.5 volts ±0.1 volt.

5. Disconnect the test DVM and replace top shield and cover.

INPUT AMPLIFIER SUBASSEMBLY

When the Input Amplifier Subassembly is replaced, or if amplifier A2 or A3, or ratio resistor kit P/N 68-0506-1 is replaced on the Input Amplifier Assembly, it is necessary to perform the operational adjustment and calibrate the assembly as follows:

1. Perform the Preliminary Procedure except depress RANGE UP switch once to put DMM in 10-volt range.

2. Position the DMM and test DVM POWER switches to on and wait 90 minutes.

3. Remove the top cover. Using the test DVM, connect the test setup shown in figure 4-2. The 6853 DMM connections and adjustments are shown in figure 4-1.

4. Connect the DMM red, black, and green leads together.

5. Vary the AMP 1 ZERO adjust control (figure 4-1) to obtain a test DVM readout of ±0.0000.

6. Depress RANGE DN switch once to put DMM in 1-volt range.

7. Vary the DC zero screwdriver adjustment on front panel for a test DVM readout of zero.

8. Depress RANGE UP switch once to put DMM in 10-volt range.

9. Repeat steps 5 through 8 until there is no interaction between the adjustments.

10. Depress RANGE AUTO switch.

11. Connect the DC voltage calibrator to the DMM signal input cable with the DMM red lead to the positive output of the voltage calibrator. Adjust the voltage calibrator output to 10.0000 volts.

12. Vary the 10V GAIN ADJ control (figure 4-1) for a test DVM readout of +10.0000.

13. Adjust the voltage calibrator output to 1.000000.

14. Vary the 1V GAIN ADJ control (figure 4-1) to obtain a test DVM readout of +1.00000.

15. Position the DMM and test DVM POWER switches to OFF. Disconnect the test DVM and DC voltage calibrator from the DMM. Replace the top cover.

COMPARATOR SUBASSEMBLY

If it is necessary to replace either amplifier A1 or A2 on the subassembly:

1. Perform the Preliminary Procedure.

2. Remove the top cover and shield.

3. Remove the subassembly from the DMM. Disconnect the A-B jumper (diagram 10) and connect to A-C. Replace the subassembly in the DMM.

4. Position the DMM and test DVM POWER switches to on. Replace the top cover and wait 90 minutes.

5. Remove the top cover. Connect the test DVM between COMP AMP 1 and REF COM (figure 4-1).

6. Vary COMP AMP 1 ZERO ADJ (figure 4-1) for a test DVM readout of ±0.0000.

7. Connect the test DVM between COMP AMP 2 and REF COM (figure 4-1).

8. Vary COMP AMP 2 ZERO ADJ (figure 4-1) for a test DVM readout as close as possible to 00000.

9. Position the DMM and test DVM POWER switches to off. Disconnect the test DVM.

10. Remove the subassembly from the DMM. Disconnect the A-C jumper and reconnect to A-B.

11. Insert the subassembly in the DMM. Replace the top shield and cover.

12. Perform the DMM calibration procedure (Section IV).

SENSITIVITY ADJUSTMENT

If the resolution of the DMM is greater than 100 microvolt on the 10-volt range perform the Sensitivity Adjustment as follows:

1. Perform the Preliminary Procedure except depress RANGE UP switch once to put DMM in 10-volt range. Position the POWER switch to on and wait 90 minutes.

2. Remove the top cover. Connect the test setup shown in figure 6-1.

3. Position the oscilloscope VOLTS/CM control to 0.1V, the TIME/CM control to 1 mSEC, the INPUT control to DC, and the POWER switch to ON.

4. Connect the oscilloscope input leads together and center the horizontal trace.

5. Connect the oscilloscope between COMP AMP 2 and REF COM (figure 4-1).

6. Adjust the output of the DC voltage calibrator to one-volt.

7. Adjust the voltage divider for a DMM reading of +0.5005.

8. Adjust the voltage divider to obtain a null on the oscilloscope (figure 6-2A).

9. Slowly increase and then decrease the output of the voltage divider while observing that the trace moves up (figure 6-2B) and then down (figure 6-2C).

10. Adjust the voltage divider to obtain a null (figure 6-2A). Note the DMM readout and the exact setting of the voltage divider.

11. Increase the setting of the voltage divider by 100 microvolts.

12. Vary the UP control to cause the DMM units windows readout to increase by one digit (figure 4-1).

13. Adjust the voltage divider to obtain a null. Note the DMM readout and exact setting of the voltage divider.

14. Repeat steps 11, 12, and 13 until a voltage divider increase of 100 microvolts causes a 1 digit increase in the DMM units window readout.

15. Adjust the voltage divider to obtain a null. Note the DMM readout and exact setting of the voltage divider.

16. Decrease the setting of the voltage divider by 100 microvolts.

17. Vary the DN control to cause the units window readout to decrease by one digit.

18. Adjust the voltage divider to obtain a null. Note the DMM readout and exact setting of the voltage divider.

19. Repeat steps 16, 17, and 18 until a voltage divider decrease of 100 microvolts causes a 1 digit decrease in the units window readout.

20. Disconnect the oscilloscope and the DMM from the test setup. Replace the DMM top cover.

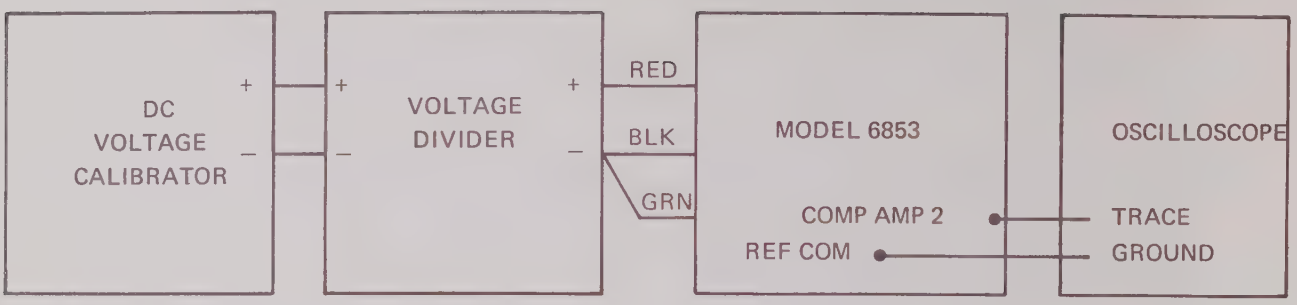


Figure 6-1. Sensitivity Adjustment Test Setup.

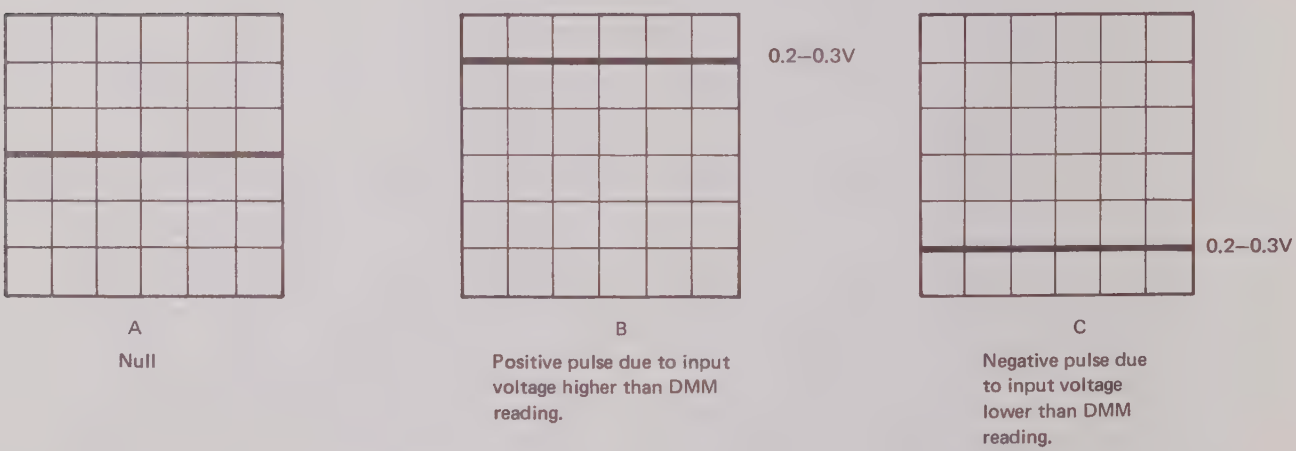


Figure 6-2. Output Waveforms at Terminal COMP AMP 2.

ASSEMBLY JUMPER CONNECTIONS

Figure 6-3 lists the jumper connections that must be made on:

1. Print Control Assembly 12-volt power supply and Print Output Assemblies to accommodate the type of logic voltage used.

2. Remote Buffer Assembly, dependent on whether internal or external power is used.

3. Print Control and Print Output Assemblies to disable the PRINT GATE command if not wanted.

4. Print Output Assemblies for externally generated READY commands and for either parallel or serial printouts.

Figure 6-3 also shows the Print Control Assembly 12-volt power supply connections to the Remote Buffer and Print Output Assemblies, and the circuit paths for the PRINT GATE and internally and externally generated READY commands.

TROUBLESHOOTING

NOTE

It is recommended that Section V, Theory of Operation, be read prior to attempting to troubleshoot the DMM.

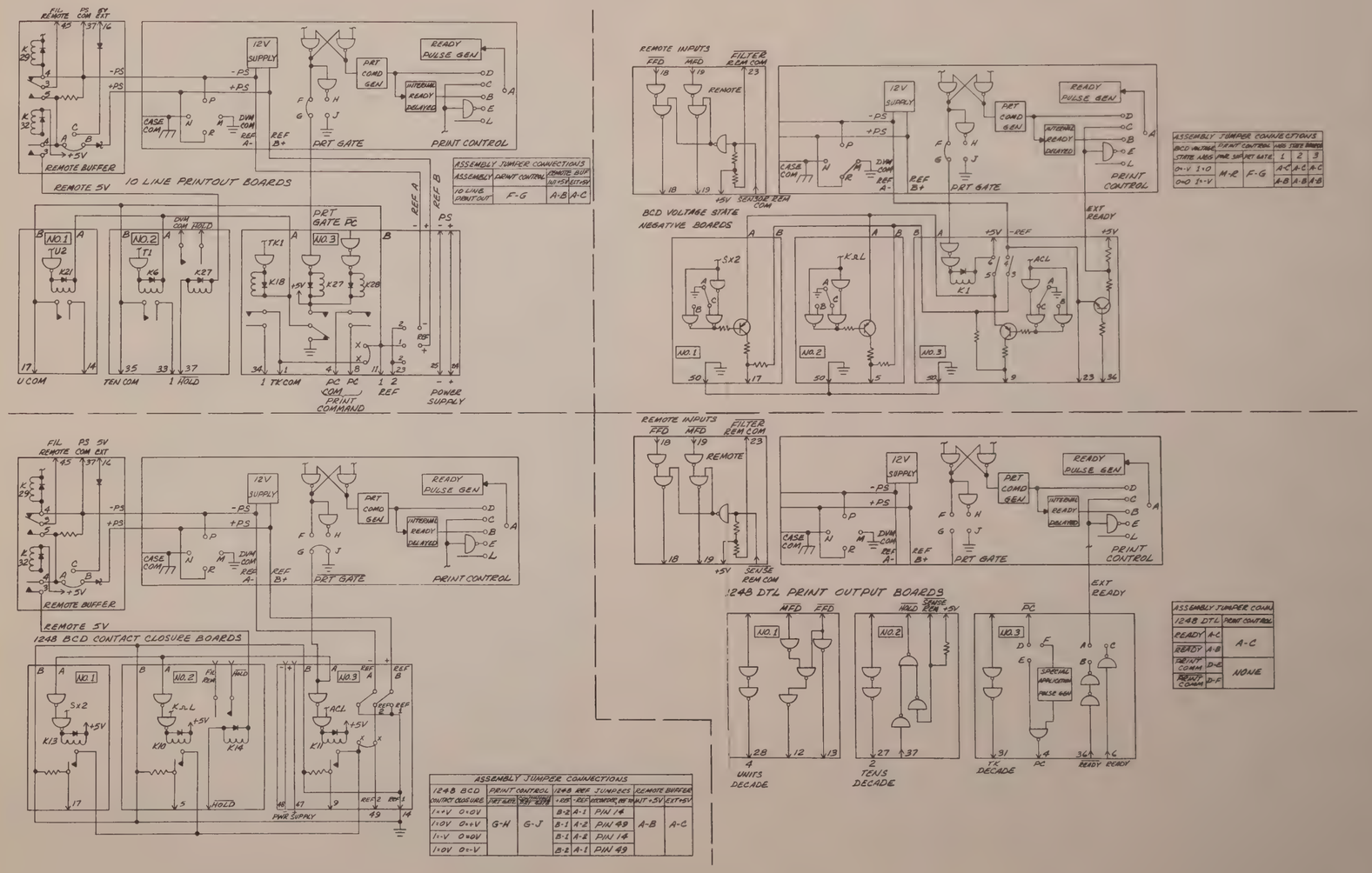


Figure 6-3. Print Control, Print Output, and Remote Assemblies Interconnections.

GENERAL

The DMM is a closed-loop instrument. If the instrument locks up and the front panel readout is 109999, an open loop is usually the cause. A 00000 lockup condition is usually caused by a shorted loop.

If a malfunction appears while measuring AC, millivolts or resistance, a quick check to determine if the associated converter or Input Selector Assembly is faulty can be made by making a DC voltage measurement. Similarly, if printouts are erroneous but the front panel readout is correct the trouble may be in the Print Control or Print Output Assemblies.

Troubleshooting of the entire DMM can be done by an assembly substitution method. Isolation of logic circuits and resistance ladder switching circuits can be done with a Cimron Logic Tester Assembly 67-6104.

WARNING

To avoid injury to personnel or damage to the instrument, power must be off when removing or inserting plug-in circuit boards.

When removing a plug-in circuit board, always use the wire board puller that is located in a mounting bracket under the top shield. Insert the board puller from the component side of the board and pull straight out. When inserting a board, lower it gently until the connectors are seated then push into place.

To remove the Print Output or Remote circuit boards, remove the two screws holding the bracket that encloses the top of the external connectors. Remove the bracket and lift the boards out with the board puller.

As an aid in mating a circuit board and its associated slot, the slot has a number printed on the master circuit board. The same number is printed on the clad side of the associated circuit board.

SUBSTITUTION METHOD

With a set of spare assembly and subassembly circuit boards, or a second properly-operating DMM from which circuit boards can be borrowed, troubleshooting the instrument is extremely simple. Since nearly all the components are mounted on plug-in circuit boards, troubleshooting is reduced to replacing suspected boards with the spare boards until the defect is remedied.

NOTE

The Comparator, the One Thousand Decoder, and the Ten Thousands Decoder Subassemblies make up one assembly. The Input Amplifier and Filter Subassemblies make up one assembly. When exchanging circuit boards all subassembly boards in an assembly must be replaced as a unit and the instrument recalibrated before continuing the troubleshooting procedure.

ISOLATION OF LOGIC COUNTING CIRCUITS AND RESISTANCE LADDER SWITCHING CIRCUITS

If the DMM fails to indicate an input signal polarity change or the numerical readout continuously runs and will not settle on a steady reading, the trouble is usually in the DMM logic circuitry or resistance ladder switching circuitry.

The following test equipment is required to localize suspected trouble in the DMM logic and resistance ladder switching circuits:

1. A 5-digit digital voltmeter with a millivolt measurement capability, a polarity readout capability, and an insulated test probe.

2. A Cimron Logic Tester Assembly, Part No. 67-6104.

There are three switches on the Logic Tester Assembly. Facing the assembly when it is inserted in the DMM:

1. The single switch on the left, when depressed, enables the Logic Tester. The DMM counting, resistance ladder switching, and polarity changing are then under control of the Logic Tester. When the switch is in the non-depressed position the Logic Tester is bypassed and counting, switching, and polarity changing are under control of the DMM logic circuits.

2. The upper switch on the right is a momentary contact switch. Each time it is pushed an UP DRIVE pulse is initiated by the Logic Tester and applied to the DMM Logic Control.

3. The lower switch on the right is a momentary contact switch. Each time it is pushed a DN DRIVE pulse is initiated.

To perform the troubleshooting procedure:

1. Remove the top cover and shield.

2. Connect the DMM red, black, and green leads together.

3. Position DMM front panel controls as shown in the Preliminary Procedure except depress RANGE UP switch once to put DMM in 10-volt range and position POWER switch to off.

4. To check the DMM 1-2-4-8 BCD logic counting and polarity switch drive circuits:

   a. Remove the Units Decade and Control Logic Assembly and replace with the Logic Tester Assembly.

   b. Insert the Units Decade and Control Logic Assembly into the connectors on top of the Logic Tester Assembly.

   c. Position the DMM POWER switch to On.

   d. Depress the switch on the left side of the Logic Tester.

   e. Repeatedly push the bottom (DN DRIVE) switch on the Logic Tester to set the DMM readout to + or –0.0000.

   f. Push the DN DRIVE switch several times and observe that the readout polarity sign changes each time. This indicates that the polarity switching logic circuitry of the Units Decade and Control Logic Assembly is functioning correctly.

NOTE

Refer to the explanation of the DMM counting logic in Section V.

   g. Repeatedly push the upper (UP DRIVE) switch on the Logic Tester and observe that the front panel units window readout changes 1-3-5-7-9. This indicates that the 1-2-4-8 BCD up-counting logic output from the Units Decade is satisfactory.

   h. Repeatedly push the UP DRIVE switch until the readout is 10.9999. If the count progress is 1-3-5-7-9 in each window, the 1-2-4-8 BCD up-counting logic output from the associated decade is satisfactory.

   i. Push the DN DRIVE switch repeatedly and observe that the Units through 1000 windows read 9-8-0 in succession. The readout should be 100000. Push the DN DRIVE switch repeatedly and observe that the overrange window goes blank and the 10,000 window changes 9-8-1-0. This step indicates the 1-2-4-8 BCD down-counting logic output from the associated decades is satisfactory.

5. To check the DMM 1-2-4-2* BCD logic counting circuits and resistance ladder switching circuits:

   a. Position POWER switch to OFF.

   b. Remove the Units, Tens, and Hundreds Decoder Assembly and replace with the 9-inch Extender Board.

   c. Insert the Assembly into the connectors on top of the Extender Board.

   d. Position the POWER switch to On.

   e. Repeatedly push the Logic Tester DN DRIVE switch until the DMM readout is 0.0000.

   f. Connect the low signal input lead of the 5-digit test DVM to REF COM (TP2) on the Input Amplifier Assembly. Connect the high signal

input lead of the test DVM to the input side (bottom) of R62 (diagram 8) and observe a test DVM readout of either + or –11 volts.

g. Push the Logic Tester DN DRIVE switch and observe that the test DVM polarity indication changes.

h. Connect the high input lead of the test DVM to the input side of R63 and observe a test DVM readout of either + or – 11 volts. Repeat step g.

i. Repeat step h for resistors R64, R65, R67 through R70, and R72 through R75. If the indicated measurements have been obtained, the 1-2-4-2* counting logic of the Units, Tens, and Hundreds Decades and the resistance ladder transistor switches on the Units, Tens, and Hundreds Decoder Assembly are satisfactory.

j. Position the POWER switch to OFF. Remove Extender Board and replace with the Units, Tens, and Hundreds Decoder Assembly.

k. Remove the One Thousand Decoder Subassembly and replace with the Extender Board. Mount the One Thousand Decoder on the Extender Board.

l. Position the POWER switch to On. Using the Logic Tester DN DRIVE switch set the DMM readout to + or –0.0000.

m. Connect the low side of the test DVM to TP2 and the high side to the input side (bottom) of R11 (diagram 17) and observe a test DVM readout of either + or –11 volts.

n. Push the Logic Tester DN DRIVE switch and observe that the test DVM polarity indication changes.

o. Connect the high side of the test DVM to the input side of R10B and observe a test DVM readout of either + or –11 volts. Repeat step n.

p. Repeat step o for resistors R10A, R9, and R8A.

q. Position POWER switch to OFF. Remove Extender Board and replace with the One Thousand Decoder Subassembly.

r. Remove the Ten Thousands Decoder Subassembly and replace with the Extender Board. Mount the Ten Thousand Decoder on the Extender Board.

s. Position the POWER switch to On. Using the Logic Tester DN DRIVE switch set the DMM readout to + or –0.0000.

t. Connect the low side of the test DVM to TP2 and the high side to the input side (bottom) of R6 (diagram 18) and observe a test DVM readout of either + or –11 volts.

u. Push the Logic Tester DN DRIVE switch and observe that the test DVM polarity indication changes.

v. Connect the high side of the test DVM to the input side of R4 and observe a test DVM readout of either + or –11 volts. Repeat step u.

w. Repeat step v for resistors R5, R3, and R2B, and R1B. If the indicated measurements have been obtained, the 1-2-4-2* counting logic of the One Thousand and Ten Thousands Decades is satisfactory.

x. Position the POWER switch to OFF. Remove the Extender Board and replace with the Ten Thousands Decoder.

y. Position the POWER switch to On. Adjust the test DVM for millivolt measurement and connect the high signal input lead to an insulated test probe.

z. Using the Logic Tester DN DRIVE switch set the DMM readout to +0.0000.

aa. Connect the low side of the test DVM to TP1 (–11 volts) on the Ten Thousands Decoder.

ab. While observing a test DVM readout of less than 500 microvolts, any polarity, connect the

test probe successively to the input side (bottom) of the One Thousand Decoder resistors R11, R10B, R10A, R9, and R8A.

ac. While observing a test DVM readout of less than 100 microvolts, any polarity, connect the test probe successively to the input side of the Ten Thousands Decoder resistors R6, R4, R5, R3, R2B, and R1B.

ad. Connect the low side of the test DVM to TP2 (+11 volts) on the Ten Thousands Decoder.

ae. Using the Logic Tester DN DRIVE switch set the DMM readout to –0.0000.

af. Repeat step ac.

ag. Repeat step ab. If the indicated measurements have been obtained, the precision resistor switches on the One Thousand and Ten Thousands Decoder Subassemblies are satisfactory.

ah. Disconnect test DVM and replace top shield and top cover.

EXTERNAL CABLES AND CONNECTORS

POWER CABLE

The power cable is connected to the DMM on the rear panel and is in series with fuse F1 mounted on the Master Board (diagram 42).

SIGNAL INPUT AND REFERENCE INPUT CONNECTORS AND CABLES

WARNING

The unused connectors should be covered with the furnished protective cap to protect personnel from electrical shock and prevent damage to connector pins.

Internal connections of the front panel signal and reference input connectors and the optional rear panel signal and reference input connectors are shown on diagram 42. When both sets of connectors are installed they are paralleled.

The connectors are connected to the Master Board as follows:

1. Signal Input Connectors by means of a 2-conductor cable to pads labeled E HI and LO. These pads are the inputs to the Input Selector Assembly, if installed.

2. Reference Input Connectors by means of a 3-conductor cable to pads labeled + and – REF. IN and guard. Pads + and – are inputs to the input Selector Assembly, if installed.

If an Input Selector Assembly is not installed:

1. Pads E HI and LO are connected by means of a teflon coaxial cable, HI Temp Wire Co. No. HX241926STJ or equivalent, to pads labeled IN HI and IN LO–inputs to the Input Amplifier Assembly.

2. Pads REF. + and – IN are connected by means of a 2-wire cable to pads labeled REF. AMP. + and – inputs to the Comparator Assembly.

3. Pads ΩØ and ANA COM are connected by means of an insulated wire.

The signal and reference input cable leads are terminated with banana jack plugs. Alligator clip adapters, gold plated for low-level voltage and ohms measurement, are part of the Cable Assembly.

PRINT OUTPUT CONNECTORS

Print output No. 1 connector J2, print output No. 2 connector J3 and print output No. 3 connector J4 extend through the rear panel and are an integral part of their associated print output assemblies. Depending upon the type of print output assemblies installed in the DMM, refer to diagrams 23 through 37 for internal connection details.

REMOTE CONNECTOR

Remote connector J1 extends through the rear panel and is an integral part of the remote assembly. Depending upon the type of remote assembly installed in the DMM, refer to diagrams 38 or 39 for internal connection details and figures 3-3 and 3-4 for external connection details.

REPAIR AND REPLACEMENT

Faulty assemblies can be returned to Cimron or a Cimron representative for repair. If it is decided to repair an assembly locally, however, parts lists and diagrams are provided in this section as an aid.

If it is necessary to replace any of the resistors that are part of ratio resistor set Part No. 67-0513-1, the complete (three subassembly boards) Comparator Amplifier, One Thousand Decoder, and Ten Thousands Decoder Assembly must be returned to the factory.

If it is necessary to replace any of the resistors that are part of precision resistor kit Part No. 68-0506-1, the complete (two subassembly boards) Input and Filter Assembly must be returned to the factory.

Replacement or repair of the Input Amplifier and Filter Assembly or the Comparator Amplifier, One Thousand Decoder, and Ten Thousands Decoder Assembly or the Power Supply Assembly requires recalibration of the instrument (Section IV).

When fuse-resistor F1 on the HIΩ-MV Converter Assembly is replaced, the assembly must be recalibrated (Section IV).

CAUTION

When replacing components on an assembly, care should be taken to prevent damage to the component from excessive heat. A low wattage soldering iron is recommended for soldering operations on the assembly. Whenever practicable, a heat sink should be used between the soldering point and the component body.

Standard electronics parts used in the instrument may be obtained locally. It is recommended, however, that precision components and mechanical parts be ordered from a Cimron representative or direct from the factory.

The specifications of diodes manufactured specially for Cimron are as follows:

CD-61, I_f = 1V greater than 100 milli amperes
I_r = 75V less than 1 micro ampere, SILICON

CD-62, I_f = 1V greater than 100 milli amperes
I_r = 250V less than 6 micro amperes, SILICON

PARTS LISTS, PARTS LOCATION DIAGRAMS, AND SCHEMATIC DIAGRAMS

The parts location diagrams and schematic diagrams of each assembly or subassembly are located immediately after the associated parts list.

Parts lists and diagrams are provided for five different print output options and two remote control options.

OPTIONAL ACCESSORIES INSTALLATION INSTRUCTIONS

CONVERTERS, AUTORANGE, PRINT AND REMOTE ASSEMBLIES

If the Model 6853 is purchased without all of the optional accessories, additional accessories can be ordered separately at a later date and installed by the customer. To install the AC Converter, HIΩ-MV Converter, 100 Megohm Range, Low Ohms Converter, Autorange, Print Control, Print Output, and Remote Assemblies:

1. Remove the top cover and shield.
2. Insert the assembly into a position already provided for it in the DMM.
3. Replace the top shield.
4. If required, calibrate the assembly (Section IV).
5. Replace the top cover.

When an AC Converter Assembly is to be installed as the AC reference voltage converter a 2-step calibration procedure is required.

The AC Converter Assembly must first be placed in the AC Converter Signal position (refer to figure 4-1,

position marked AC CONV SIG 13) and calibrated to AC Signal Input Converter calibration instructions in Section IV.

The assembly then is placed in the AC Converter Reference position (refer to figure 4-1, position marked AC CONV REF 13) and calibrated to AC Reference Voltage Converter calibration instructions in Section IV.

INPUT SELECTOR ASSEMBLY

When a DMM is purchased without the Input Selector Assembly, two 2-conductor cables are installed in its place. If the Input Selector is purchased at a later date, the cables must be removed before the Input Selector can be used:

To install the Input Selector Assembly:

1. Remove the bottom cover and shield.
2. Remove the cable connecting Master Board pads labeled E HI and LO and pads IN HI and IN LO.
3. Remove the cable connecting pads labeled REF. + and – IN and pads labeled REF AMP + and –.
4. Remove the insulated wire connecting pads labeled Ω∅ and ANA COM.
5. Replace the bottom shield and cover.
6. Remove the top cover and shield.
7. Insert the Input Selector Assembly in the slot provided for it.
8. Replace the top shield and cover.

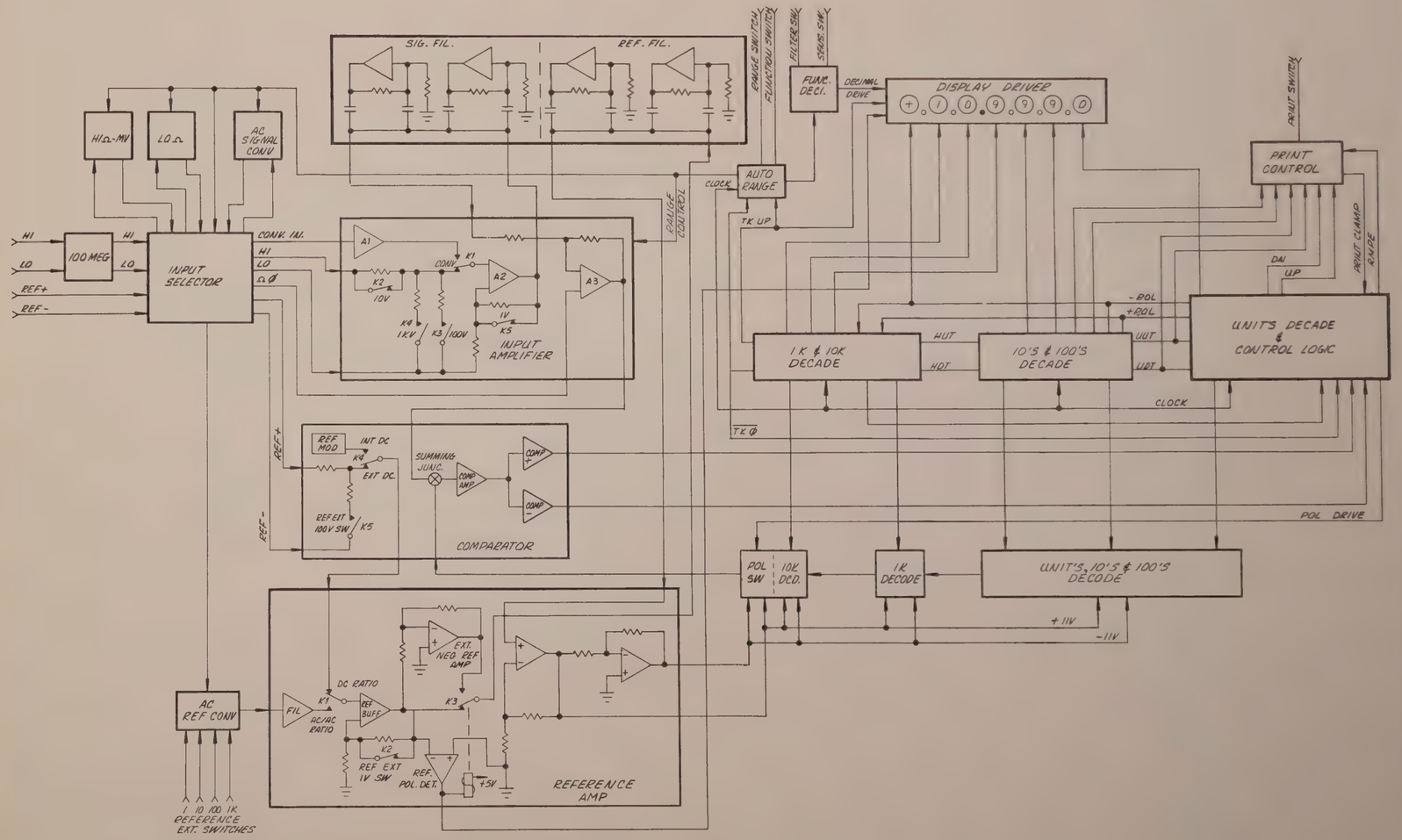
REAR INPUT CONNECTOR

To install the Rear Input Connector:

1. Remove the DMM top and bottom covers and shields.
2. Remove the chrome plated press-in plug (J1R) from the rear panel.
3. Secure the Input Connector in place with the hardware provided.
4. Insert the Input Connector Cabling through the hole provided in the Master Board beneath the connector.
5. Connect the cabling as shown on diagram 42.
6. Replace the top and bottom shields and covers.

MOUNTING HARDWARE

Optional mounting hardware such as bench stands, rack mounting brackets, or slide rails can be bolted on the instrument in the places provided for them.



Model 6853 Block Diagram.

6-13/14

ORIGINAL

INPUT SELECTOR

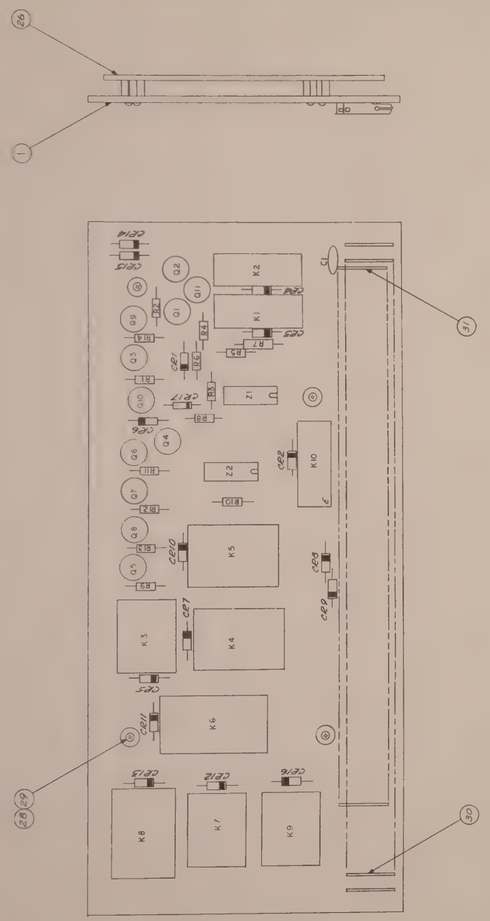
ASSEMBLY 68-6035

PARTS LIST

ASSEMBLY: Input Selector SCHEMATIC NO.: 68-0735 PART NO.: 68-6035

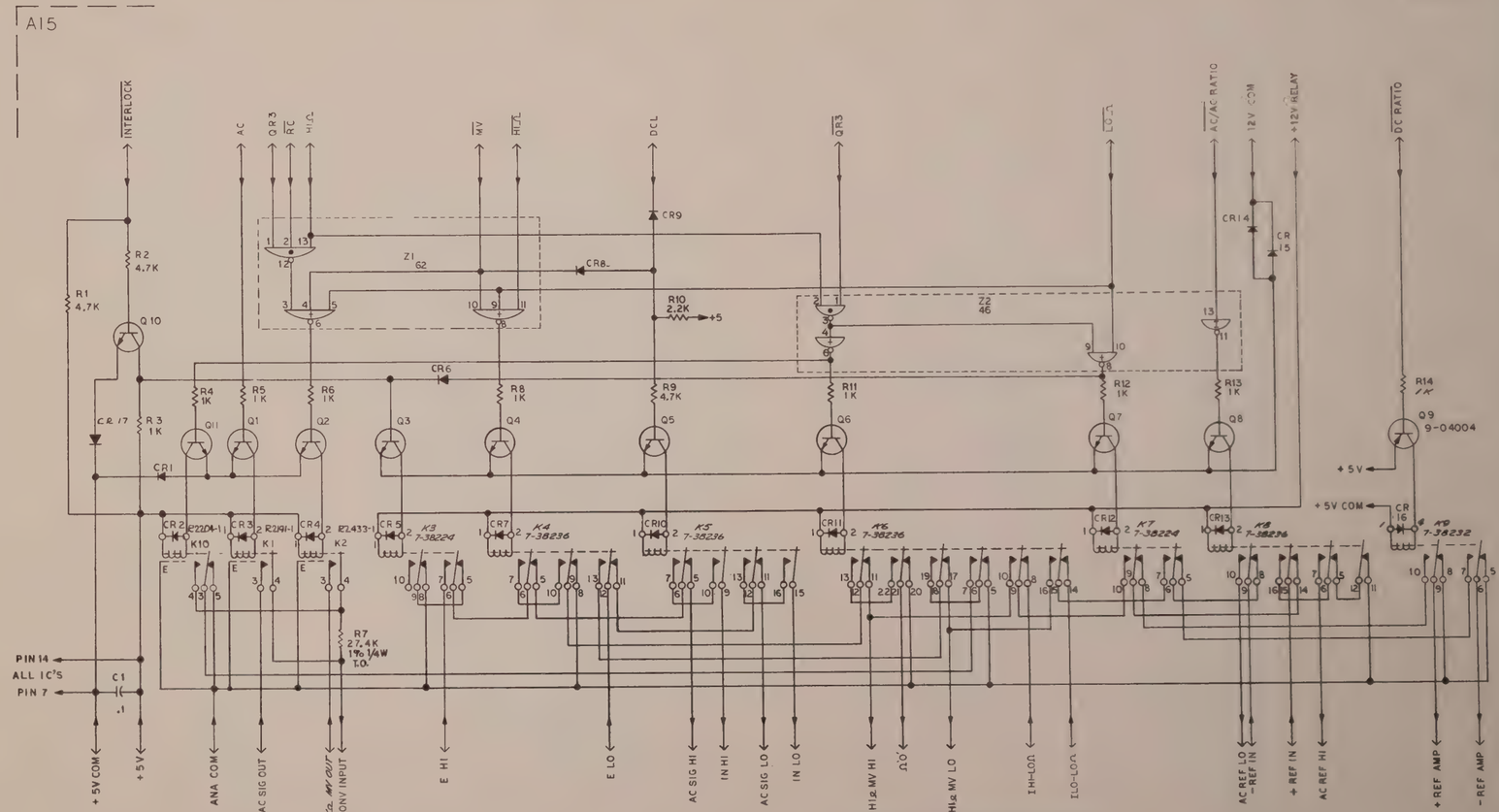
ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 15)	CIMRON PART NO.	
1	1	ETCHED CIRCUIT BOARD		68-7035	
2					
3	1	CAP CER DISC 0.1 10V	C1	1-57525	
4					
5	17	DIODE	CR1-CR17	7-95647	
6					
7	1	RELAY, REED, R2433-1	K2	7-38243	
8	1	RELAY REED, R2191-1	K1	7-38228	
9	1	RELAY REED, R2204-1	K10	7-38231	
10	1	RELAY, R10-E2-Z2 6V	K9	7-38232	
11	2	RELAY, R10-E2-Z2-S800-12V	K3 & K7	7-38224	
12	3	RELAY, R10-E2-Z4-SS1K-12V	K4, K5, K8	7-38236	
13	1	RELAY, R10-E2-Z6-S320-12V	K6	7-38244	
14					
15	9	RES COMP 1K	R3-6, R8, R11-14	7-41243	
16	1	RES COMP 2.2K	R10	7-41247	
17	3	RES COMP 4.7K	R1, R2, R9	7-41251	
18	1	RES TIN OXIDE 27.4K 1% 1/4W	R7	7-46791	
19					
20	10	TRANSISTOR NPN 2N2222	Q1-8, Q10-11	9-04003	
21	1	TRANSISTOR PNP	Q9	9-04004	
22					
23	1	INT CIRCUIT 846	Z2	7-96008	
24	1	INT CIRCUIT 862	Z1	7-96010	
25					
26	1	SHIELD		68-2028-1	
27					
28	4	SCREW 4-40 x 3/8 TRUSS HD PHILLIPS		7-89204-6	
29	4	WASHER - FLAT METALIC		9-51504-1	
30	27	CONTACT ELECT		2-63904	
31	10	CONTACT ELECT, UPPER		2-63907	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



NOTES:
UNLESS OTHERWISE SPECIFIED:
1. FOR SCHEMATIC SEE 68-0135
2. ASSEMBLY PERFORMED ON COMPONENT SIDE OF PCB AS SHOWN
FOR COMPLETE DESIGNATOR PREFIX WITH A15

A15



X = ON
O = OFF

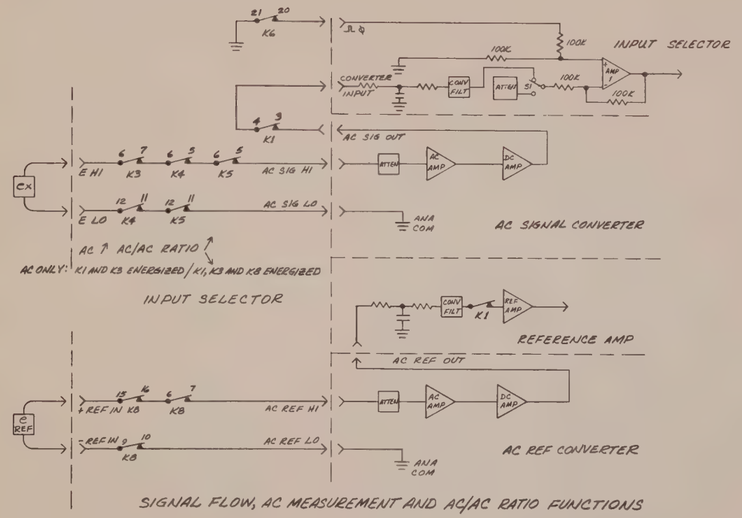
FUNCTION	K4	K5	K6	K7	K8	K3	K2	K1	K9	K10
100 MEG Ω	O	X	O	O	O	X	O	O	O	O
AC RATIO	O	O	O	O	X	X	O	X	O	O
DC	O	X	O	O	O	X	O	O	O	O
MV	X	O	O	O	O	X	X	O	O	O
Lo Ω 4WIRE	X	O	O	O	X	X	X	O	O	O
HI Ω 2WIRE	X	O	O	O	O	X	X	O	O	O
HI Ω 4WIRE	X	O	X	X	O	X	O	O	O	X
AC	O	O	O	O	O	X	O	X	O	O
DC RATIO	O	X	O	O	O	X	O	O	X	O

NOTES: UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ARE IN OHMS, ±5%, 1/4W
2. ALL CAPACITORS ARE IN μF
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A15
4. R14 Q11, CR17, K10, C1, NONE
   Z2 LAST NUMBER USED, NUMBER NOT USED
5. DIODES ARE CYNRON P/N 7-95647
6. TRANSISTORS ARE 9-04003
7. FOR ASSEMBLY SEE 68-6035

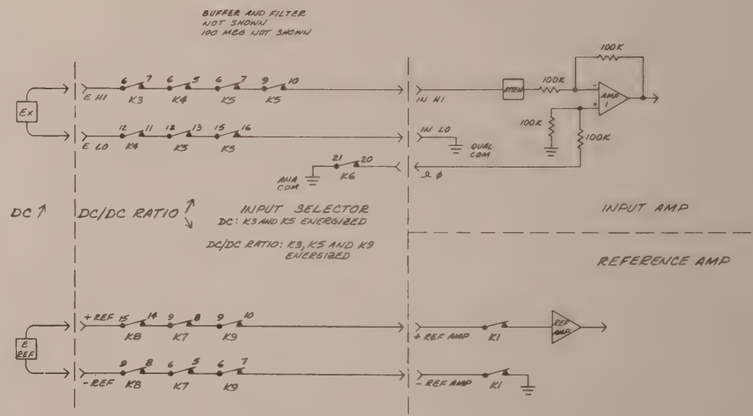
Input Selector.

6-17/18

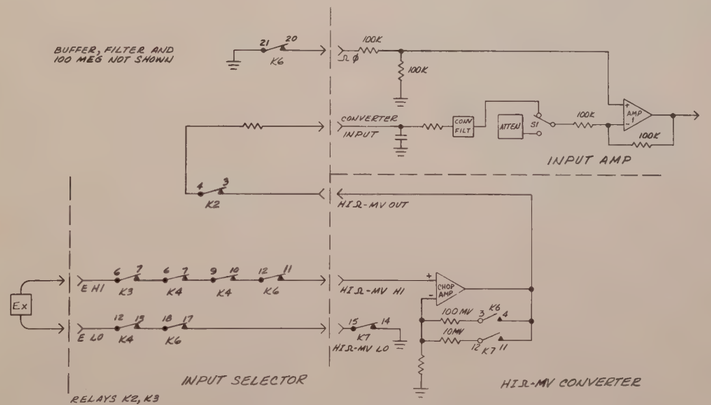
ORIGINAL



SIGNAL FLOW, AC MEASUREMENT AND AC/AC RATIO FUNCTIONS



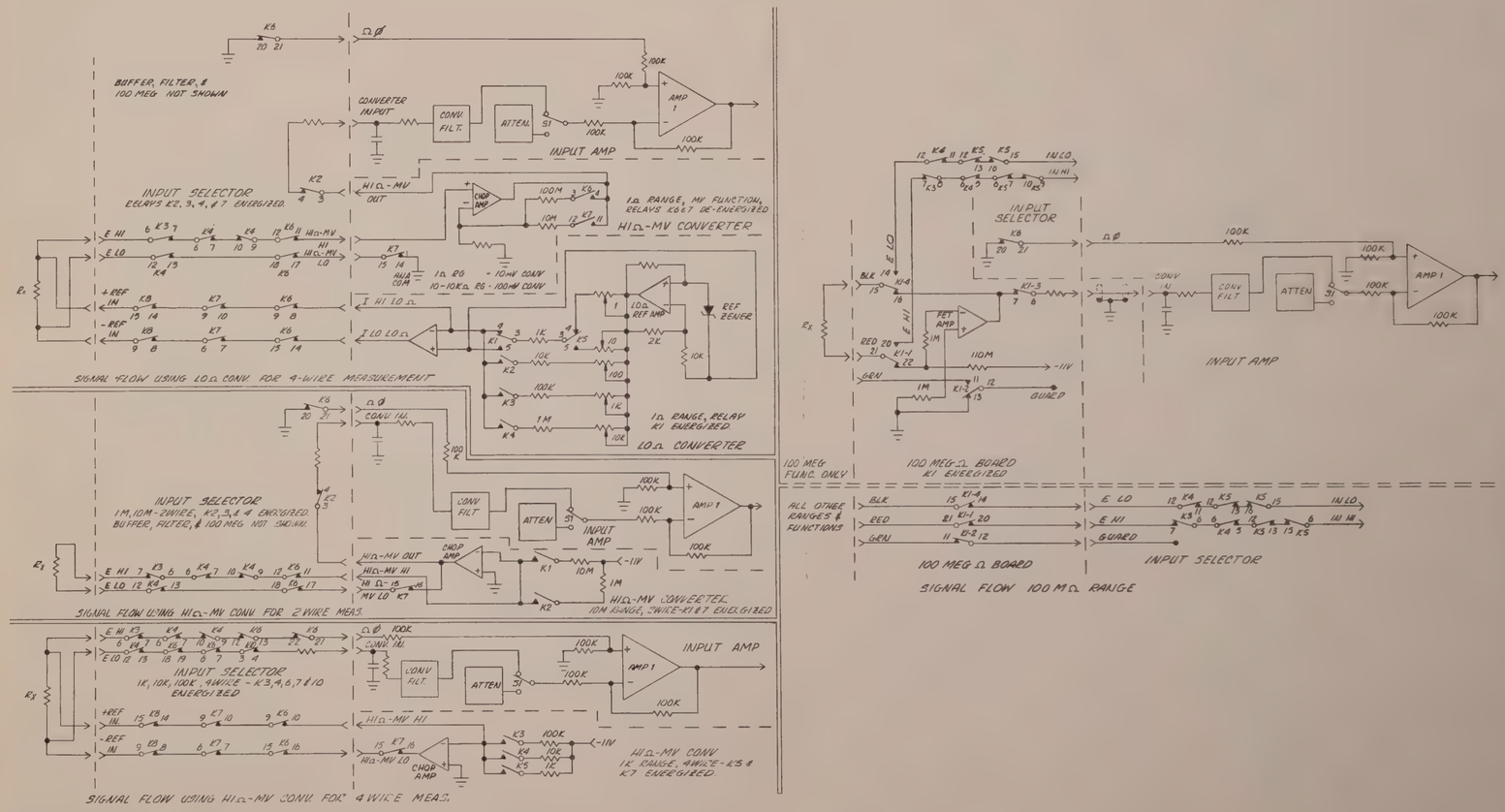
SIGNAL FLOW, DC MEASUREMENT AND DC/DC RATIO FUNCTIONS



SIGNAL FLOW, MILLIVOLT MEASUREMENT FUNCTION

Model 6853 Signal Flow Diagram (Sheet 1 of 2).

6-19/20


BUFFER, FILTER, & 100 MEG NOT SHOWN
INPUT SELECTOR
RELAYS K2, 3, 4, & 7 ENERGIZED
CONVERTER INPUT
CONV. FILT.
ATTEN.
INPUT AMP
AMP 1
CHOP AMP
1Ω RANGE, MV FUNCTION, RELAYS K6 & 7 DE-ENERGIZED
HIΩ-MV CONVERTER
1Ω RS - 10MV CONV
10-10KΩ RS - 100MV CONV
REF ZENER
SIGNAL FLOW USING LOΩ CONV FOR 4-WIRE MEASUREMENT
1Ω RANGE, RELAY K1 ENERGIZED
LOΩ CONVERTER
INPUT SELECTOR
1M, 10M-2WIRE, K2, 3, & 4 ENERGIZED. BUFFER, FILTER, & 100 MEG NOT SHOWN.
SIGNAL FLOW USING HIΩ-MV CONV FOR 2 WIRE MEAS.
10M RANGE, 2WIRE-K3 & 7 ENERGIZED
INPUT SELECTOR
1K, 10K, 100K, 4WIRE - K3, 4, 6, 7 & 10 ENERGIZED
HIΩ-MV CONV
1K RANGE, 4WIRE - K5 & K7 ENERGIZED.
SIGNAL FLOW USING HIΩ-MV CONV FOR 4 WIRE MEAS.
100 MEG FUNC ONLY
100 MEG Ω BOARD K1 ENERGIZED
ALL OTHER RANGES & FUNCTIONS
100 MEG Ω BOARD
INPUT SELECTOR
SIGNAL FLOW 100 MΩ RANGE

NOTES~ UNLESS OTHERWISE SPECIFIED:

1. RESISTORS ARE IN OHMS.

Model 6853 Signal Flow Diagram (Sheet 2 of 2).

6-21/22

ORIGINAL

MODEL 5875 AC CONVERTER

ASSEMBLY 57-6000

PARTS LIST

ASSEMBLY: Model 5875 AC Converter SCHEMATIC NO.: 57-0700 PART NO.: 57-6000

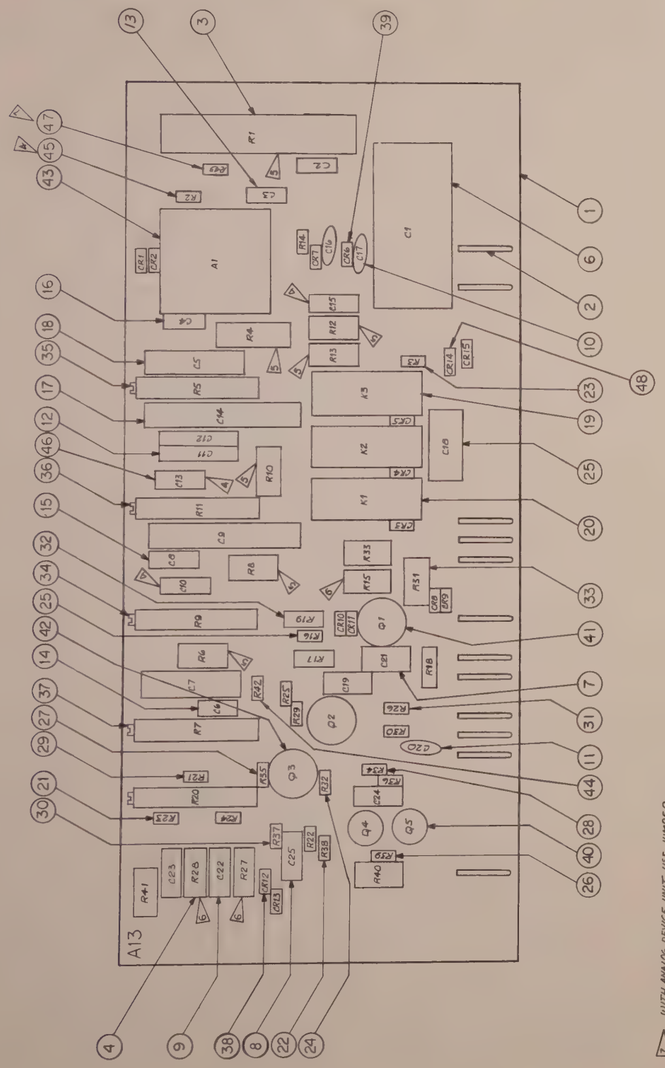
ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 13)	CIMRON PART NO.	
1	1	CKT BD – ETCHED		57-7000	
2	12	CONTACT, ELECT		2-63904	
3	1	RES KIT	R1, R4, R6, R8, R10, R12, R13	57-0500-1	
4	1	RES KIT	R15, R27, R28	57-0501-1	
5	1	CAP TANT 330 6V	C18	1-57101	
6	1	CAP MET MY 0.5 1000V	C1	1-57357	
7	1	CAP MET MY 0.1 200V	C21	1-57370	
8	3	CAP SIL MICA 33 pF 500V	C19, C24, C25	1-57464	
9	2	CAP SIL MICA 50 pF 500V	C22, C23	1-57487	
10	2	CAP CER DISC 0.0047 1000V	C16, C17	1-57501	
11	1	CAP CER DISC 0.0022 1000V	C20	1-57502	
12	2	CAP GLASS 5100 pF 300V	C11, C12	1-57604	
13	2	CAP GLASS 51 pF 500V	C2, C3	1-57613	
14	1	CAP GLASS 91 pF 500V	C6	1-57619	
15	1	CAP GLASS 1000 pF 300V	C8	1-57620	
16	1	CAP GLASS 27 pF 500V	C4	1-57621	
17	2	CAP VAR 0.8-30 pF 1000V	C9, C14	1-63000	
18	2	CAP VAR GLASS 0.8-18 pF 750V	C5, C7	1-63002	
19	2	RELAY REED	K2, K3	7-38228	
20	1	RELAY REED	K1	7-38231	
21	2	RES COMP 10	R23, R24	7-41219	
22	3	RES COMP 82	R25, R29, R38	7-41230	
23	2	RES COMP 390	R3, R14	7-41238	
24	1	RES COMP 470	R32	7-41239	
25	1	RES COMP 1.2K	R16	7-41244	
26	1	RES COMP 2.2K	R39	7-41247	
27	1	RES COMP 10K	R35	7-41255	
28	1	RES COMP 15K	R34	7-41257	
29	2	RES COMP 22K	R21, R22	7-41259	
30	2	RES COMP 47K	R36, R37	7-41263	
31	2	RES COMP 68K	R26, R30	7-41265	
32	3	RES T.O. 499K 1%	R17-R19	7-46772	
33	4	RES 55.4K 0.1%	R31, R33, R40, R41	7-47344	
34	1	RES 200	R9	7-54274	
35	1	RES 5K	R5	7-54276	
36	1	RES 20	R11	7-54278	
37	2	RES 2K	R7, R20	7-54279	

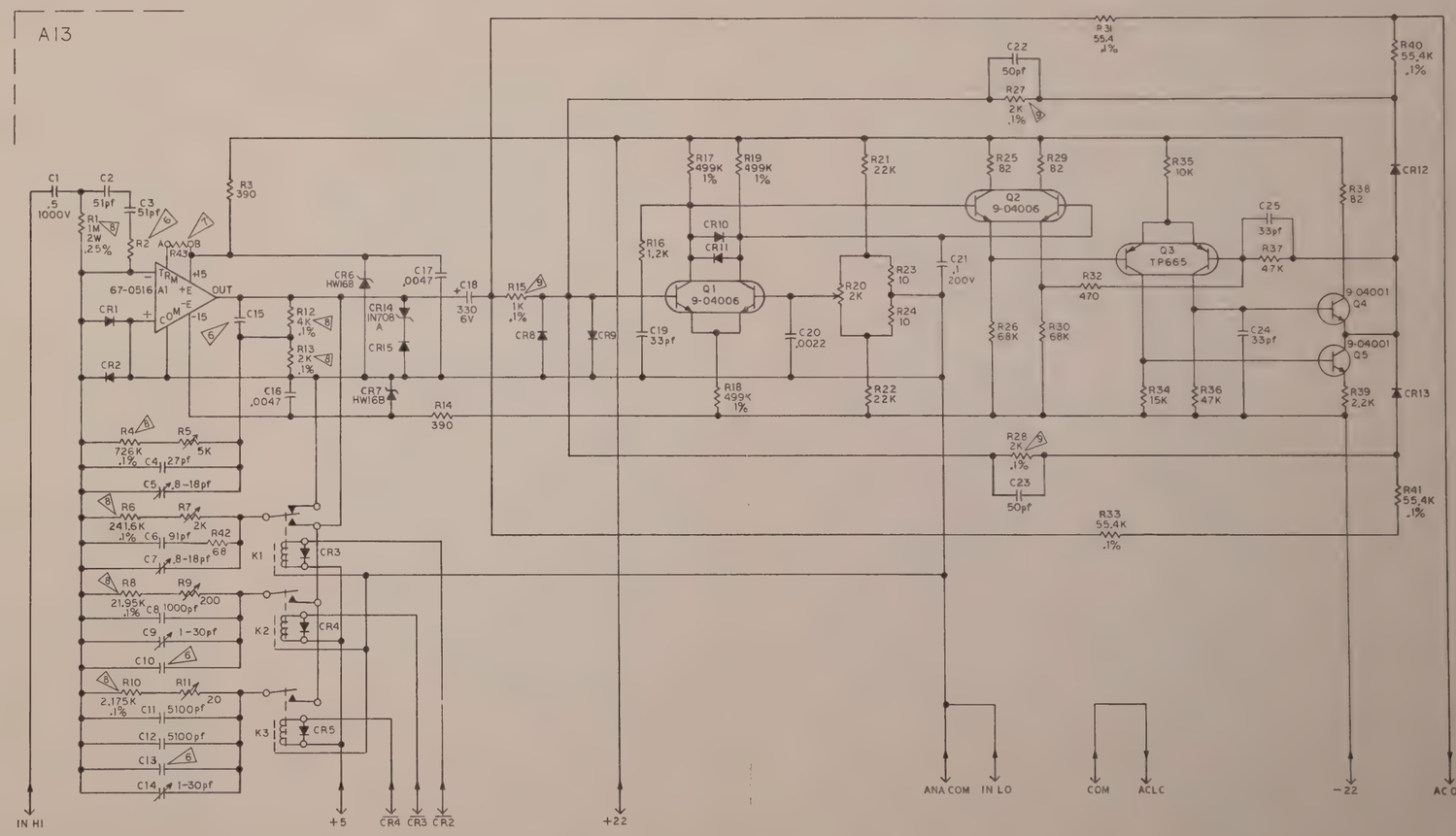
NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.

PARTS LIST

ASSEMBLY: Model 5875 AC Converter		SCHEMATIC NO.: 57-0700		PART NO.: 57-6000	
ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 13)	CIMRON PART NO.	
38	12	DIODE	CR1-CR5, CR8-CR13, CR15	7-95647	
39	2	DIODE	CR6, CR7	7-95672	
40	2	TRANSISTOR NPN	Q4, Q5	9-04001	
41	2	TRANSISTOR DUAL NPN	Q1, Q2	9-04006	
42	1	TRANSISTOR DUAL PNP	Q3	9-04810	
43	1	AMP	A1	67-0516-1	
44	1	RES COMP 68	R42	7-41229	
45	1	RES COMP, FACT. SEL. VALUE	R2		
46	3	CAP, FACTORY SELECTED VALUE	C10, C13, C15		
47	1	RES COMP 1K	R43	7-41243	
48	1	DIODE ZENER	CR14	7-95631	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.





WITH ANALOG DEVICE UNIT USE JUMPER
WITH PHILBRICK NEXUS UNIT USE 1K RESISTOR

FURNISHED AS PART OF RES KIT 57-0501-1

FURNISHED AS PART OF RES KIT 57-0500-1

SELECTED VALUE

NOTES: UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ARE IN OHMS, ±5%, ¼W
2. ALL CAPACITORS ARE IN MF
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A13

NOTES: UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ARE IN OHMS, ±5%, ¼W
2. ALL CAPACITORS ARE IN MF
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A13
4. R43 — A1, C25, CR15, K3, Q5 — LAST NUMBER USED | NUMBER NOT USED
5. DIODES ARE IN914
6. FACTORY SELECTED VALUE

7. WITH ANALOG DEVICE UNIT USE JUMPER
WITH PHILBRICK NEXUS UNIT USE 1K RESISTOR

8. RESISTORS ARE PARTS OF RESISTOR KIT NO. 57-0501.

9. RESISTORS ARE PARTS OF RESISTOR KIT NO. 57-0500

AC Converter.

6-27/28

MODEL 5889 HIΩ-MV CONVERTER

ASSEMBLY 58-6015

PARTS LIST

ASSEMBLY: HIΩ-MV Converter SCHEMATIC NO.: 58-0715 PART NO.: 58-6015

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 14)	CIMRON PART NO.	
1	1	ETCHED CIRCUIT BOARD		58-7015	
2	21	CONTACT ELECT		2-63904	
3					
4	2	NUT HEX 4-40		6-36504-6	
5	2	WASHER LOCK SPLIT		9-52704	
6					
7					
8	1	CAP M PAP 1.0 10% 50V	C7	1-57317	
9	2	CAP M PAP .47 10% 50V	C8, C10	1-57318	
10	3	CAP M PAP .22 10% 50V	C2, C4, C9	1-57319	
11	1	CAP POLY STY 1 10% 100V	C11	1-57361	
12	1	CAP POLY STY .047 100V	C3	1-57383	
13	1	CAP CER DISC .1 10V	C1	1-57525	
14	1	CAP MICA 2 pF	C6	1-62001	
15	1	CAP VAR .5 TO 5 pF	C5	1-63004	
16					
17	1	FUSE RESISTOR 100 1%	R58	4-09013	
18	1	FUSE RESISTOR 2K 5%	R57	4-09014	
19					
20	6	RELAY REED R2191-1	K1-K6	7-38228	
21	1	RELAY R10E-702	K7	7-38230	
22					
23	2	RES COMP 120	R51, R52	7-41232	
24	2	RES COMP 330	R44, R46	7-41237	
25	3	RES COMP 470	R50, R53, R56	7-41239	
26	3	RES COMP 680	R1, R2, R54	7-41241	
27	2	RES COMP 1K	R41, R42	7-41243	
28	1	RES COMP 4.7K	R27	7-41251	
29	2	RES COMP 10K	R47, R48	7-41255	
30	4	RES COMP 15K	R11, R19, R39, R40	7-41257	
31	1	RES COMP 22K	R55	7-41259	
32	6	RES COMP 33K	R28, R30, R34, R35, R37, R38	7-41261	
33	2	RES COMP 47K	R29, R31	7-41263	
34	3	RES COMP 100K	R36, R43, R45	7-41267	
35	1	RES M FILM 1 MEG 1% 1/4W	R24	7-46220	
36	1	RES M FILM 10.75M .25% 1/2W	R3	7-46224	
37	2	RES TIN OXIDE 4.75K 1% 1/4W	R6, R8	7-46700	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.

PARTS LIST

ASSEMBLY: HIΩ-MV Converter SCHEMATIC NO.: 58-0715 PART NO.: 58-6015

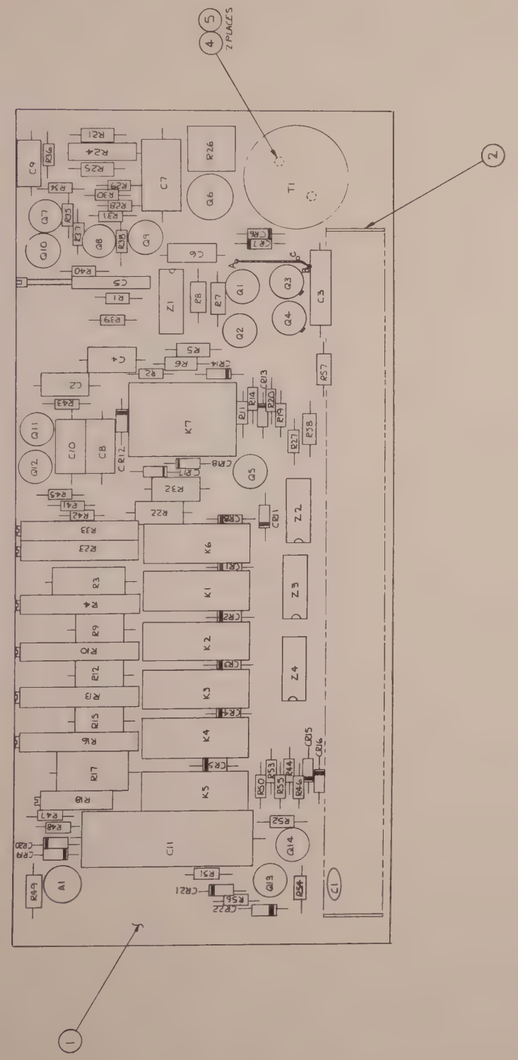
ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 14)	CIMRON PART NO.	
38	2	RES TIN OXIDE 10K 1% 1/4W	R25, R49	7-46701	
39	2	RES TIN OXIDE 15K 1% 1/4W	R5, R7	7-46717	
40	1	RES TIN OXIDE 523K 1% 1/8W	R21	7-46722	
41	1	RES WW 100Ω .1% 1/3W	R26	7-47111	
42	1	RES WW 995 .1% 1/2W	R17	7-47331	
43	1	RES WW 10.875K .1% 1/4W	R15	7-47332	
44	1	RES WW 10.94K .1% 1/4W	R22	7-47333	
45	1	RES WW 99.4K .1% 1/4W	R32	7-47334	
46	1	RES WW 109.8K .1% 1/4W	R12	7-47335	
47	1	RES WW 1.0974M .1% 1/4W	R9	7-47336	
48	1	RES VAR 10	R18	7-54286	
49	1	RES VAR 200	R13	7-54289	
50	1	RES VAR 1K	R33	7-54305	
51	1	RES VAR 50	R16	7-54308	
52	1	RES VAR 100	R23	7-54309	
53	1	RES VAR 5K	R10	7-54310	
54	1	RES VAR 500K	R4	7-54313	
55	2	RES COMP 8.2K	R14, R20	7-41254	
56	14	DIODE 1N914	CR1-CR5, CR8, CR11-CR14, CR19-CR22	7-95647	
57	2	DIODE HW16B	CR15, CR16	7-95672	
58	2	DIODE FD300	CR6, CR7	7-95505	
59	2	DIODE HW18A	CR17, CR18	7-95676	
60					
61	1	INT CIRCUIT MC832	Z1	7-96004	
62	1	INT CIRCUIT MC846	Z2	7-96008	
63	2	INT CIRCUIT MC862	Z3, Z4	7-96010	
64					
65	1	AMPLIFIER 741	A1	7-96073	
66					
67	1	TRANSISTOR NPN CIMRON SPEC/ 2N930	Q13	9-04001	
68	1	TRANSISTOR NPN CIMRON SPEC/ 2N2222	Q5	9-04003	
69	5	TRANSISTOR PNP	Q1, Q2, Q9, Q10, Q14	9-04004	
70	1	TRANSISTOR DUAL NPN	Q6	9-04006	
71	2	TRANSISTOR 2N4302 FET	Q11, Q12	9-04733	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.

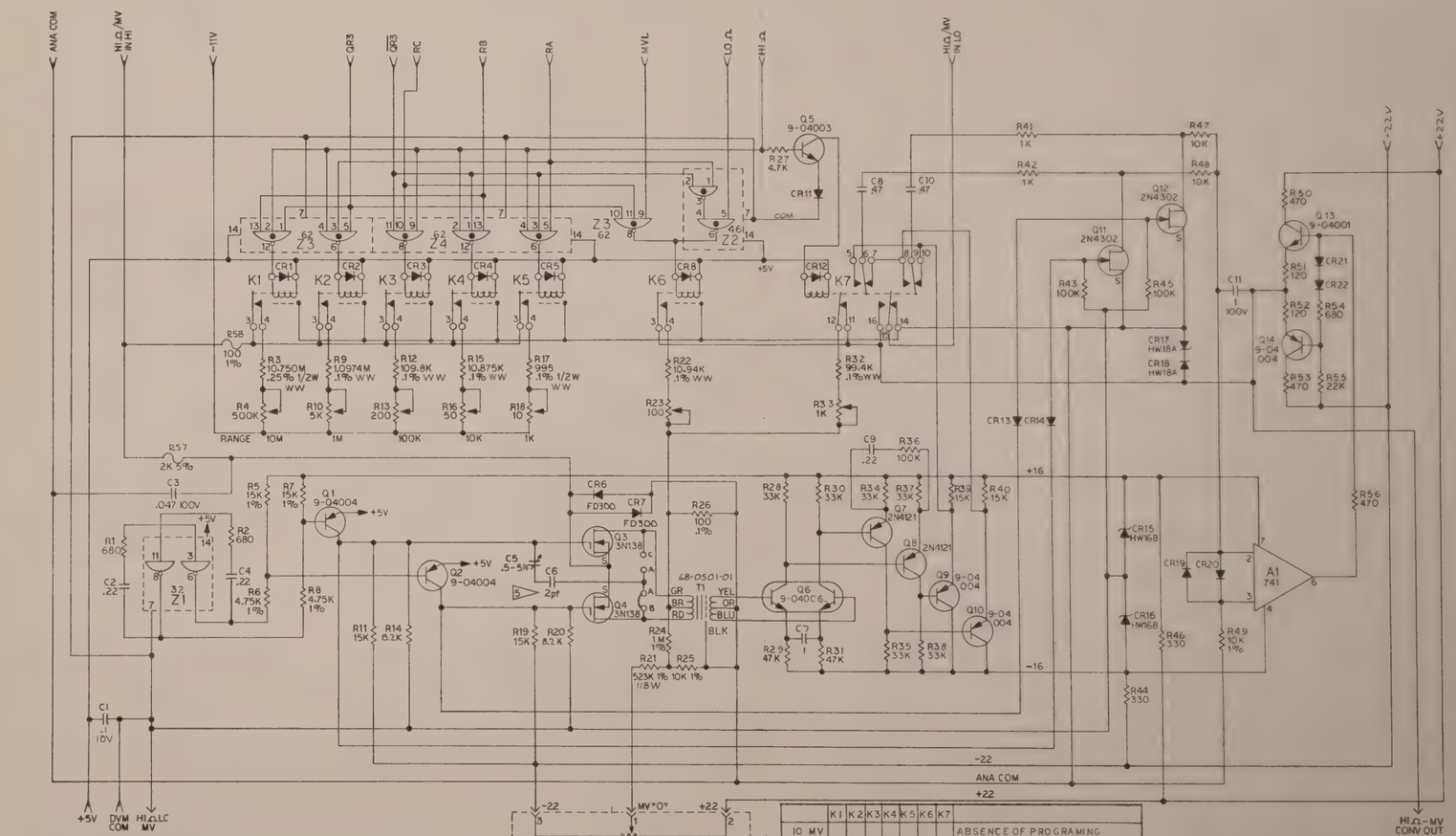
PARTS LIST

ASSEMBLY: HIΩ-MV Converter			SCHEMATIC NO.: 58-0715		PART NO.: 58-6015
ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 14)	CIMRON PART NO.	
72	2	TRANSISTOR 3N138 MOS FET	Q3, Q4	9-04757	
73	2	TRANSISTOR 2N4121	Q7, Q8	9-04806	
74	1	TRANSFORMER	T1	68-0501-01	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



2. FOR SCHEMATIC DIAGRAM, SEE SB-0713
INDIVIDUAL PART SPECIFICATIONS SHOWN FOR
COMPLETE DESIGNATOR PREFIX A14
NOTES UNLESS OTHERWISE SPECIFIED



	K1	K2	K3	K4	K5	K6	K7	
10 MV								ABSENCE OF PROGRAMING
100 MV						X		LΩ·$\overline{QR3}$·(CRB+RQ+MVL·RC·QR3
1K					X		X	HIΩ·$\overline{QR3}$·RA
10K				X			X	HIΩ·QR3·RB
100K			X				X	HIΩ·QR3·RC
1M		X					X	HIΩ·QR3·RA
10M	X						X	HIΩ·QR3·RB

6. SEE SB-6013 FOR ASSEMBLY
5. FACTORY SELECTED VALUE NOM VALUE SHOWN
4. DIODES ARE 1N914
Q14,R58,T1
A1,C11,CR22,F2,K7, CR9 CR10
LAST NUMBER USED NUMBER NOT USED
3. PARTIAL REFERENCE DESIGNATIONS SHOWN. FOR
COMPLETE DESIGNATOR PREFIX A14
2. ALL CAPACITORS ARE IN MIRCO FARADS 50V, 10%
1. ALL RESISTORS ARE IN OHMS ±5%, 1/4W

NOTES: UNLESS OTHERWISE SPECIFIED

HIΩ-MV Converter.

6-33/34

ORIGINAL

100 MEGOHM RANGE

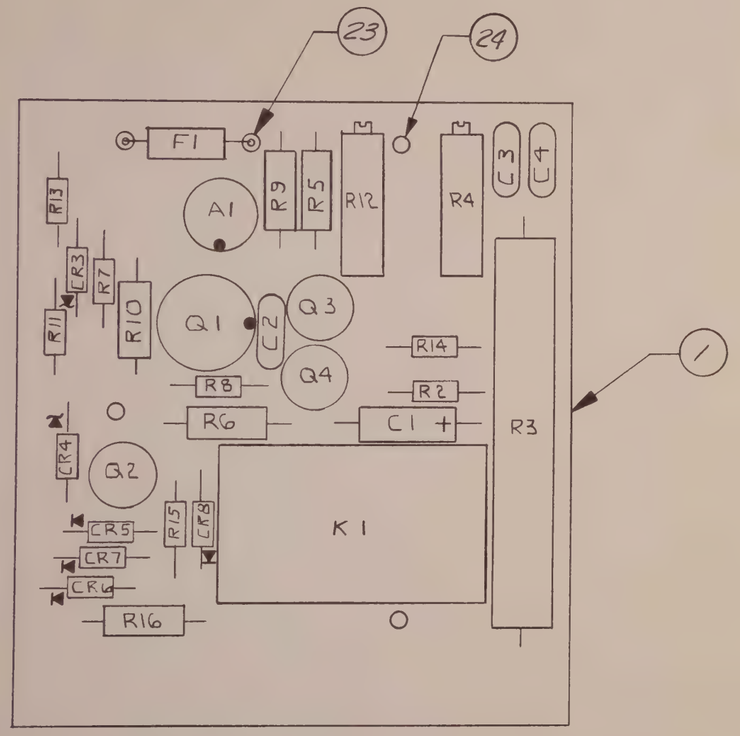
ASSEMBLY 68-6058

PARTS LIST

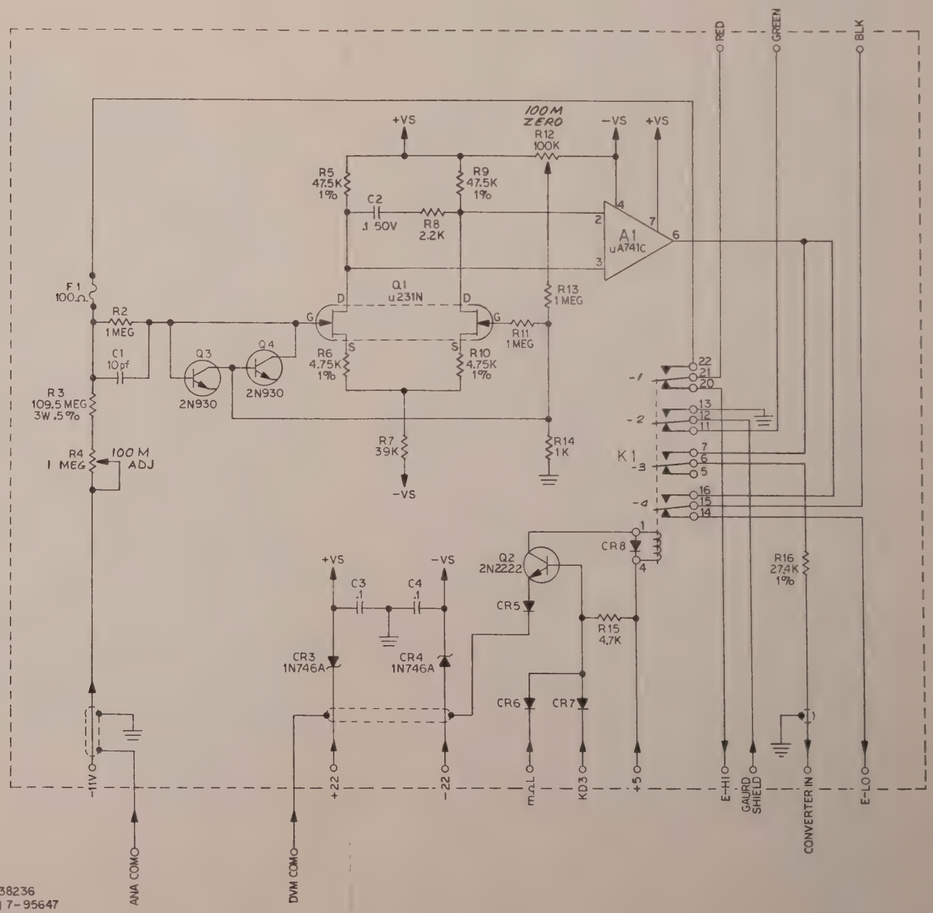
ASSEMBLY: 100 Megohm Range SCHEMATIC NO.: 68-0758 PART NO.: 68-6058

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 26)	CIMRON PART NO.	
1	1	ETCHED CKT BD		68-7058	
2	1	CAP CER DISC 10 pF	C1	1-57527	
3	3	CAP CER DISC 0.1 50V	C2, C3 & C4	1-57529	
4	1	FUSE 100	R1	4-09013	
5	1	RELAY PARELCO	K1	7-38237	
6	1	RES COMP 1K	R14	7-41243	
7	1	RES COMP 2.2K	R8	7-41247	
8	1	RES COMP 4.7K	R15	7-41251	
9	1	RES COMP 39K	R7	7-41262	
10	3	RES COMP 1M	R2, R11, R13	7-41279	
11	2	RES TIN OXIDE 4.75K 1%	R6, R10	7-46700	
12	2	RES TIN OXIDE 47.5K 1%	R5, R9	7-46702	
13	1	RES TIN OXIDE 27.4K 1%	R16	7-46791	
14	1	RES FILM 109.5M 0.5% 3W	R3		
15	1	RES VAR 100K	R12	7-54311	
16	1	RES VAR 1M	R4	7-54314	
17	2	DIODE ZENER 1N746A	CR3, CR4	7-95618	
18	4	DIODE 1N914	CR5, 6, 7, & 8	7-95647	
19	1	AMP UA741C	A1	7-96060	
20	2	TRANS NPN	Q3, Q4	9-04001	
21	1	TRANS NPN CIMRON SPEC 2N2222	Q2	9-04003	
22	1	DUAL FET U231	Q1	9-04787	
23	2	TURRET STANDOFF		8-91109	
24	3	EYELET		3-58004	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



NOTES:
UNLESS OTHERWISE SPECIFIED:
1. FOR SCHEMATIC SEE 68-0758
2. REFERENCE DESIGNATIONS SHOWN ARE INCOMPLETE AND SHOULD BE PREFIXED BY A26



7. RELAY K1 IS CIMRON P/N 7-38236
6. ALL DIODES ARE CIMRON P/N 7-95647
5. FOR ASSEMBLY SEE 68-7058
4. A1, C4, CR8, Q2, R16, K1 / R1
   LAST NUMBER USED / NUMBER NOT USED
3. PARTIAL REFERENCE DESIGNATIONS SHOWN COMPLETE DESIGNATOR PREFIX A26
2. ALL CAPACITORS ARE IN uf
1. ALL RESISTORS ARE IN OHMS ±5%, 1/4W

NOTES: UNLESS OTHERWISE SPECIFIED:

100 Megohm Range.

6-37/38

ORIGINAL

MODEL ~~5889~~ LOW OHMS CONVERTER

ASSEMBLY 58-6014

PARTS LIST

ASSEMBLY: Low Ohms Converter Model 5889 SCHEMATIC NO.: 58-0714 PART NO.: 58-6014

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 12)	CIMRON PART NO.	
1	1	ETCHED CIRCUIT BOARD		58-7014	
2	17	CONTACT ELECT		2-63904	
3	8	INSULATOR TRANSISTOR PAD		5-07106	
4					
5					
6					
7	3	CAP TANT 2.2 35V	C2, C8, C9	1-57104	
8	2	CAP ELECT 50 50V	C10, C11	1-57257	
9	1	CAP M PAP 0.1 50V	C7	1-57321	
10					
11					
12	1	CAP CER DISC 0.1 10V	C1	1-57525	
13	1	CAP CER DISC 0.2 50V	C5	1-57543	
14	2	CAP ELECT 150 40V	C12, C13	1-59014	
15	1	CAP POLY 0.1 μF 10% 20V	C4	1-57339	
16					
17	1	OVEN DIODE 3ST1-1	HR1	6-40003	
18					
19					
20	6	RELAY REED R2191-1	K1-K6	7-38228	
21					
22	1	RES COMP 470 5% 1/2W	R19	7-41039	
23	1	RES COMP 4.7K 5% 1/2W	R18	7-41051	
24	1	RES COMP 33	R20	7-41225	
25	1	RES MET FILM 100 0.1% 1/4W	R11	7-47111	
26	2	RES COMP 220	R28, R31	7-41235	
27	3	RES COMP 1K	R1, R29, R32	7-41243	
28	1	RES VAR 1K WW	R14	7-54305	
29	3	RES COMP 22K	R30, R33, R34	7-41259	
30	2	RES TIN OXIDE 1.82K 1%	R22, R23	7-46731	
31	2	RES TIN OXIDE 13.3K 1%	R25, R26	7-46745	
32	2	RES TIN OXIDE 18.2K 1%	R24, R27	7-46750	
33	1	RES COMP 100	R17	7-41231	
34	1	RES WW 10K 0.1% 5PPM	R16	7-47174	
35	1	RES WW 995 0.1%	R2	7-47331	
36	1	RES WW 10.875K 0.1%	R8	7-47332	
37	1	RES WW 109.8K 0.1%	R9	7-47335	
38	1	RES WW 1.097M 0.1%	R10	7-47336	

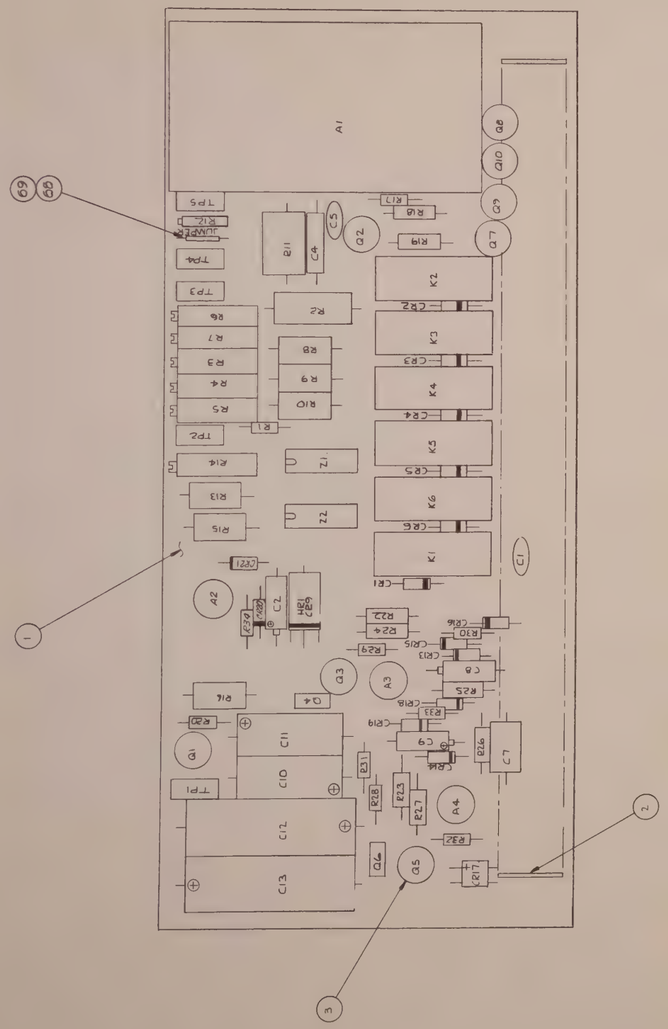
NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.

PARTS LIST

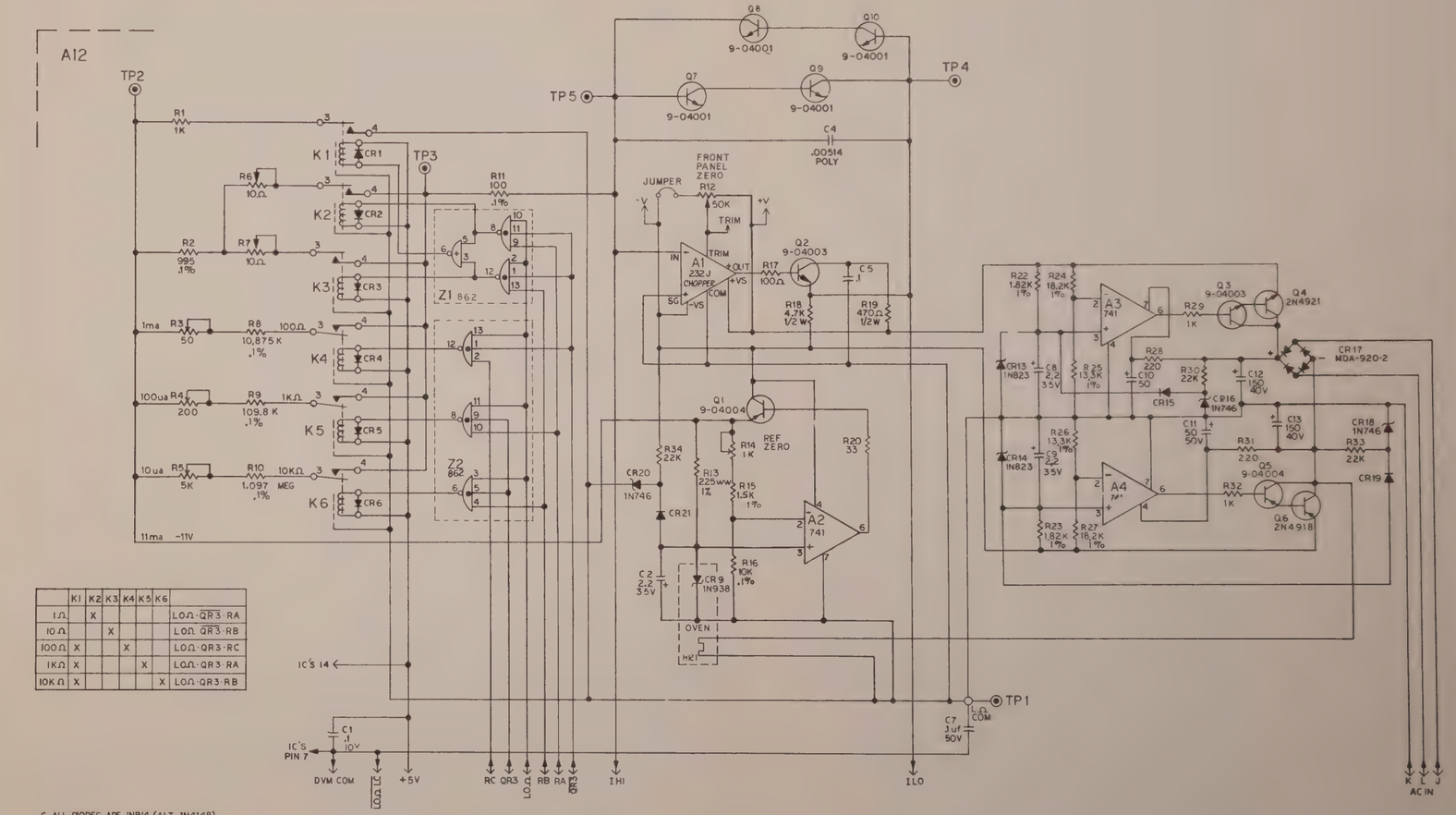
ASSEMBLY: Low Ohms Converter Model ~~5889~~ 5891 SCHEMATIC NO.: 58-0714 PART NO.: 58-6014

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 12)	CIMRON PART NO.	
39	1	RES WW 225 0.1% 5PPM	R13	7-47372	
40	1	RES WW 1.5K 0.1% 5PPM	R15	4-47364	
41	2	RES VAR 10	R6, R7	7-54286	
42	1	RES VAR 200	R4	7-54289	
43	1	RES VAR 5K	R5	7-54310	
44	1	RES VAR 50	R3	7-54308	
45	1	RES VAR 50K	R12	7-54283	
46	1	DIODE 1N938	CR9	7-95617	
47	2	DIODE 1N746A	CR18, CR20	7-95618	
48	10	DIODE 1N914	CR1-6, CR15, CR16, CR19 CR21	7-95647	
49	1	DIODE MDA 920-2	CR17	7-95660	
50	2	DIODE 1N823	CR13, CR14	7-95667	
51					
52	2	INT CIRCUIT MC862	Z1, Z2	7-96010	
53					
54					
55	1	AMPLIFIER 232J	A1	7-96072	
56	3	AMPLIFIER 741	A3, A4, A2	7-96073	
57					
58	4	TRANSISTOR	Q7-Q10	9-04001	
59	2	TRANSISTOR	Q2, Q3	9-04003	
60	2	TRANSISTOR	Q1, Q5	9-04004	
61	1	TRANSISTOR 2N4921	Q4	9-04760	
62	1	TRANSISTOR 2N4918	Q6	9-04817	
63	1	TEST JACK - BROWN	TP1	5-19004	
64	1	TEST JACK - RED	TP2	5-19002	
65	1	TEST JACK - ORANGE	TP3	5-19006	
66	1	TEST JACK - YELLOW	TP4	5-19008	
67	1	TEST JACK - GREEN	TP5	5-19005	
68	A/R	WIRE-BARE 24 GA		9-81024	
69	A/R	TUBING - TEFLON		9-07724	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



4. SEE DWG. SA-0049 FOR SCHEM. DIA.
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A12
2. ALL CAPACITORS ARE IN MFD.
1. ALL RESISTORS ARE IN OHMS ±5% 1/4W
NOTES: UNLESS OTHERWISE SPECIFIED



	K1	K2	K3	K4	K5	K6	
1Ω		X					LOΩ·$\overline{QR3}$·RA
10Ω			X				LOΩ·$\overline{QR3}$·RB
100Ω	X			X			LOΩ·QR3·RC
1KΩ	X				X		LOΩ·QR3·RA
10KΩ	X					X	LOΩ·QR3·RB

6. ALL DIODES ARE IN914 (ALT. 1N4148)

4. R34, K6
C13, A4, CR21, Q622 | CR7-CR12
LAST NUMBER USED | NUMBER NOT USED
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A12
2. ALL CAPACITORS ARE IN MF
1. ALL RESISTORS ARE IN OHMS, ±5%, ¼W
NOTES: UNLESS OTHERWISE SPECIFIED

Low Ohms Converter.

6-43/44

ORIGINAL

FILTER AND INPUT AMPLIFIER

ASSEMBLY 68-5009

AND

INPUT AMPLIFIER

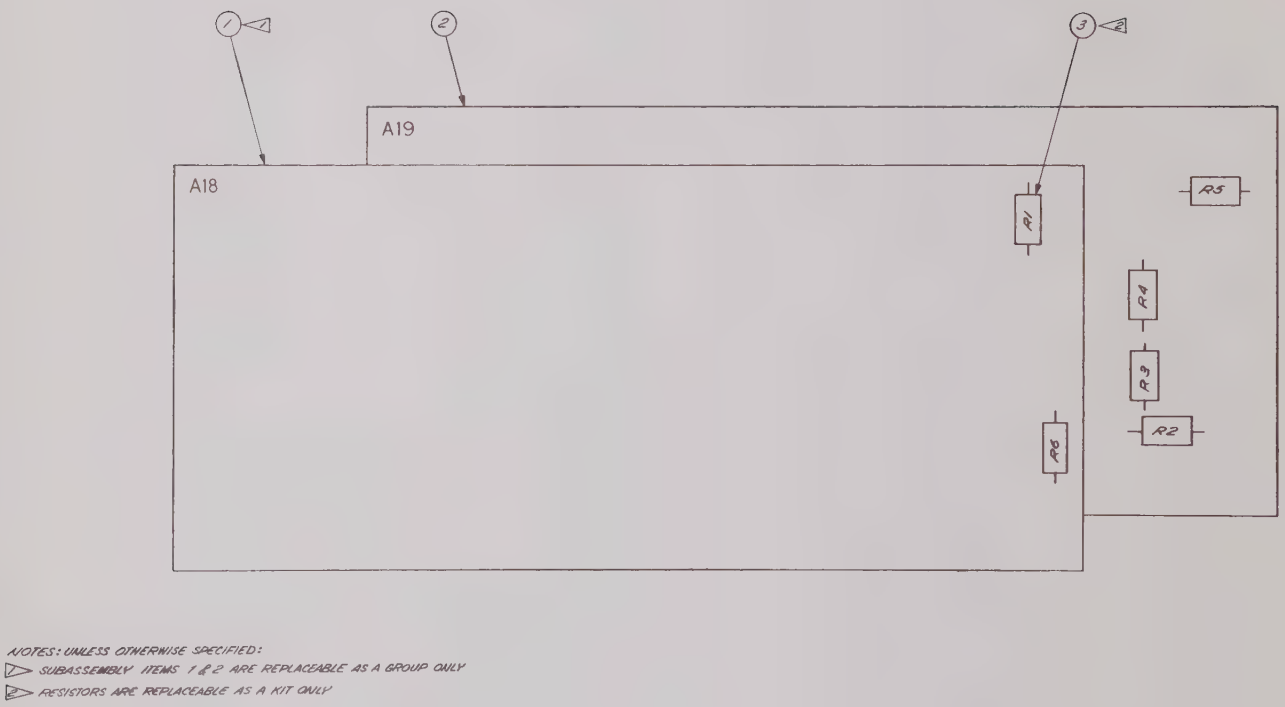
SUBASSEMBLY 68-6038

PARTS LIST

ASSEMBLY: Filter and Input Amplifier SCHEMATIC NO.: PART NO.: 68-5009

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES	CIMRON PART NO.	
1	1	INPUT AMPLIFIER SUBASSEMBLY	A18	68-6038	
2	1	FILTER SUBASSEMBLY	A19	68-6039	
3	1	RESISTOR KIT	R1-R6	68-0506-1	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



NOTES: UNLESS OTHERWISE SPECIFIED:
1 SUBASSEMBLY ITEMS 1 & 2 ARE REPLACEABLE AS A GROUP ONLY
2 RESISTORS ARE REPLACEABLE AS A KIT ONLY

Figure 6-4. Filter and Input Amplifier Assembly.

PARTS LIST

ASSEMBLY: Input Amplifier, Sub Assembly SCHEMATIC NO.: 68-0738 PART NO.: 68-6038

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 18)	CIMRON PART NO.	
1	1	ETCHED CIRCUIT BOARD		68-7038	
2	1	SHIELD		68-2030-1	
3	21	CONTACT ELECT (LOWER)		2-63904	
4	5	CONTACT ELECT (UPPER)		2-63907	
5	8	INSULATOR TRANSISTOR PAD		5-07106	
6	4	SCREW RD HD NO. 4-40 x 1/4		7-89104-4	
7	17	TERMINAL - TEFLON		8-91114	
8	4	WASHER LOCK NO. 4		9-52504	
9	1	AMPLIFIER	A3 (& R36)	0-05000	
10	1	AMPLIFIER	A2	0-05001	
11					
12	2	CAP TANT 10 20V	C8, C9	1-57112	
13	1	CAP M PAP 0.22 10% 50V	C11	1-57319	
14	2	CAP M PAP 0.1 10% 50V	C12, C13	1-57321	
15	3	CAP POLY STY 0.1 50V	C1, C5, C7	1-57397	
16	1	CAP POLY STY 0.15 50V	C2	1-57398	
17	1	CAP SIL MICA 200 pF	C4	1-57474	
18	1	CAP CER DISC 0.0047	C3	1-57501	
19	1	CAP CER DISC 0.1 10V	C6	1-57525	
20	1	CAP GLASS 2200 pF 10% 500V	C10	1-57601	
21	1	TEST JACK, PC-RED	TP2	5-19002	
22	1	TEST JACK, PC-BROWN	TP1	5-19004	
23	1	RES KIT	R8, R11, R18	5-40021	
24	1	REED DRG-DTH FORM C	S1	7-38246	
25	2	REED SPST GOLD DRG-1	S3, S4	7-38208	
26	1	REED	S5	7-38216	
27					
28	3	RES COMP 10	R23, R24, R35	7-41219	
29	1	RES COMP 22	R29	7-41223	
30	1	RES COMP 47	R25	7-41227	
31	2	RES COMP 470	R14, R15	7-41239	
32	5	RES COMP 1K	R7, R10, R16, R20, R30	7-41243	
33	1	RES COMP 1.5K	R22	7-41245	
34	1	RES COMP 68K	R21	7-41265	
35	1	RES COMP 100K	R17	7-41267	
36	1	RES COMP 560K 5% 2W	R9	7-45076	
37	1	RES TIN OXIDE 27.4K 1%	R13	7-46791	
38	1	RES TIN OXIDE 75K 1%	R26	7-46828	

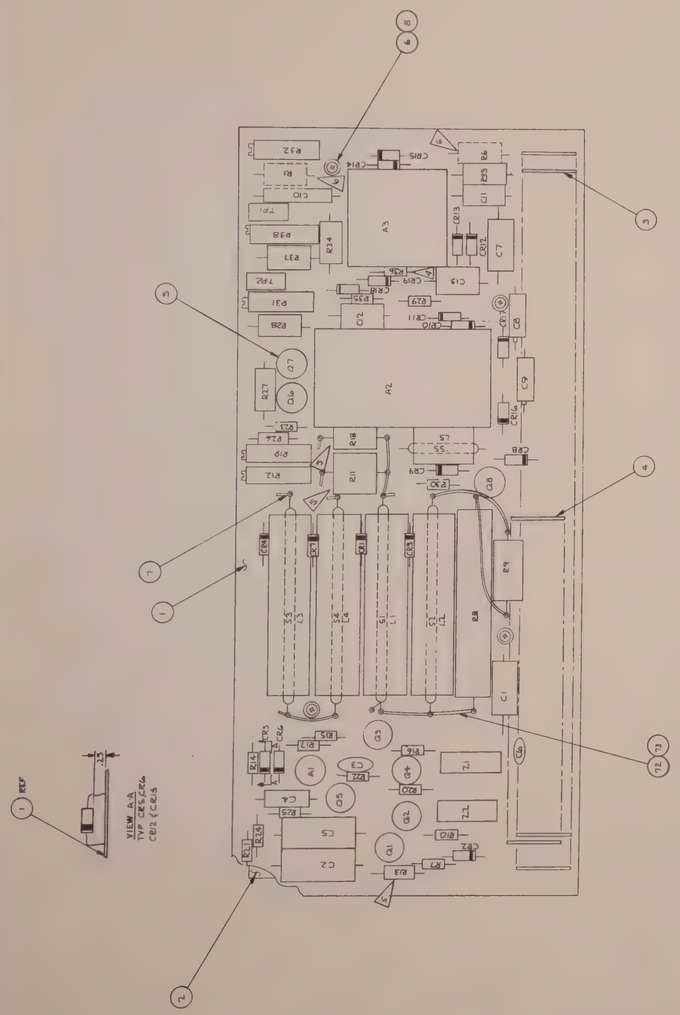
NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.

PARTS LIST

ASSEMBLY: Input Amplifier, Sub Assembly SCHEMATIC NO.: 68-0738 PART NO.: 68-6038

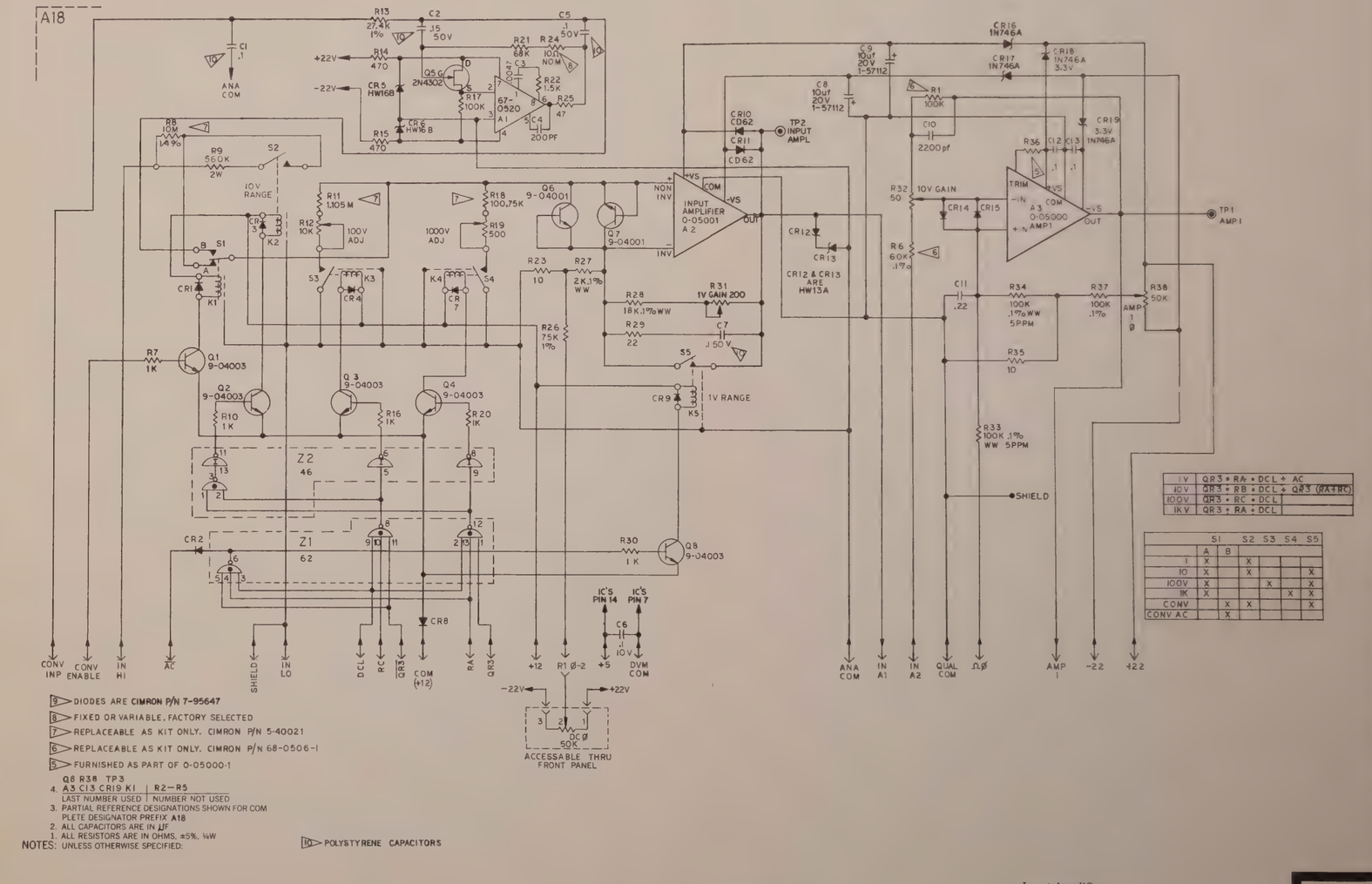
ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 18)	CIMRON PART NO.	
39	1	RES WW 2K 0.1% 5PPM 1/4W	R27	7-47345	
40	1	RES WW 18K 0.1% 5PPM 1/4W	R28	7-47346	
41	3	RES WW 100K 0.1% 5PPM 1/4W	R33, R34, R37	7-47349	
42	1	RES VAR 50K	R38	7-54283	
43	1	RES VAR 500	R19	7-54285	
44	1	RES VAR 10K	R12	7-54288	
45	1	RES VAR 200	R31	7-54289	
46	1	RES VAR 50	R32	7-54308	
47					
48	2	DIODE CD 62	CR10, CR11	7-95507	
49	4	DIODE 1N746A	CR16-CR19	7-95618	
50					
51	9	DIODE 1N914	CR1-CR4, CR7-CR9, CR14, CR15	7-95647	
52	2	DIODE ZENER HW16B	CR5, CR6	7-95672	
53	2	DIODE ZENER HW13A	CR12, CR13	7-95673	
54					
55	1	INT CIRCUIT MC 846	Z2	7-96008	
56	1	INT CIRCUIT MC 862	Z1	7-96010	
57					
58	2	TRANSISTOR NPN CIMRON SPEC 2N930	Q6, Q7	9-04001	
59	5	TRANSISTOR NPN CIMRON SPEC 2N2222	Q1-Q4, Q8	9-04003	
60	1	TRANSISTOR 2N4302	Q5	9-04733	
61					
62	1	REED DRG-AH	S2	46-0513	
63					
64	1	AMPLIFIER	A1	67-0520	
65					
66					
67					
68	2	COIL REED DRIVE	L3, L4	70-0501-1	
69	2	COIL REED DRIVE	L1, L2	80-0508-1	
70	1	COIL REED DRIVE	L5	90-0504	
71					
72	A/R	WIRE-COPPER TINNED 24 GA		9-81024	
73	A/R	TUBING - TEFLON NO. 24		9-07724	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



VIEW A-A
TYP CR5,CR6a
CR12 & CR13

NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS, ±5%, ¼W
2. ALL CAPACITORS ARE ±#
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPONENTS ON CIRCUIT BOARD PREFIX A18
4. A3 C13 CR19 K1 | R2–R5
   LAST NUMBER USED | NUMBER NOT USED
5. R36 FURNISHED AS PART OF O-05000-1
6. Q8,R31,R3 ARE REPLACEABLE AS A KIT ONLY PN 5-40021
7. R1 R6 ARE PART OF PN 68-0506-1 ½ ARE REPLACEABLE AS A KIT ONLY



	SI		S2	S3	S4	S5
	A	B				
1	X		X			
10	X		X			X
100V	X			X		X
1K	X				X	X
CONV		X	X			X
CONV AC		X				

1V	QR3 + RA + DCL + AC
10V	QR3 + RB + DCL + QR3 (RA+RC)
100V	QR3 + RC + DCL
1KV	QR3 + RA + DCL

NOTES: UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ARE IN OHMS, ±5%, ¼W
2. ALL CAPACITORS ARE IN µF
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A18
4. A3 C13 CR19 K1 | R2–R5
   LAST NUMBER USED | NUMBER NOT USED
5. FURNISHED AS PART OF O-05000-1
6. REPLACEABLE AS KIT ONLY. CIMRON P/N 68-0506-1
7. REPLACEABLE AS KIT ONLY. CIMRON P/N 5-40021
8. FIXED OR VARIABLE, FACTORY SELECTED
9. DIODES ARE CIMRON P/N 7-95647
10. POLYSTYRENE CAPACITORS

Input Amplifier.

6-51/52

ORIGINAL

FILTER

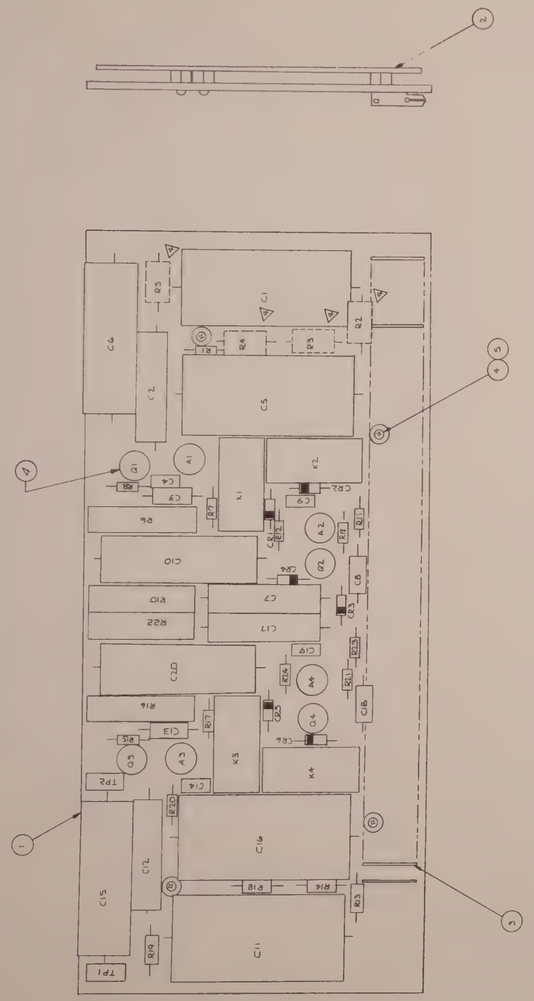
SUBASSEMBLY 68-6039

PARTS LIST

ASSEMBLY: Filter Subassembly SCHEMATIC NO.: 68-0739 PART NO.: 68-6039

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 19)	CIMRON PART NO.	
1	1	CIRCUIT BOARD, ETCHED		68-7039	
2	1	SHIELD		68-2042	
3	11	CONTACT ELECT		2-63904	
4	4	INSULATOR, TRANSISTOR PAD		5-07106	
5	4	SCREW RD HD NO. 4-40 x 1/4		7-89104-4	
6	4	WASHER LOCK INT TOOTH NO. 4		9-52504	
7	2	CAP POLY STY 1 100V	C10, C20	1-57361	
8	4	CAP POLY STY 0.22 100V	C2, C7, C12, C17	1-57364	
9	2	CAP POLY STY 0.68 100V	C6, C15	1-57389	
10	4	CAP POLY 2 50V	C1, C5, C11, C16	1-57390	
11	4	CAP SIL MICA 430 pF	C3, C8, C13, C18	1-57481	
12	4	CAP CER DISC 220 pF	C4, C9, C14, C19	1-57509	
13					
14					
15	4	RELAY REED R2192	K1-K4	7-38227	
16	4	RES COMP 47	R8, R12, R20, R24	7-41227	
17	4	RES COMP 15K	R7, R11, R17, R23	7-41245	
18	4	RES COMP 47K	R1, R9, R15, R21	7-41263	
19	4	RES TIN OXIDE 10K 1%	R13, R14, R18, R19	7-46701	
20	2	RES VAR 200K	R6, R16	7-54312	
21	2	RES VAR 500K	R10, R22	7-54313	
22					
23					
24	2	DIODE 1N746A	CR3, CR4	7-95618	
25	4	DIODE 1N914	CR1, CR2, CR5, CR6	7-95647	
26					
27	4	TRANSISTOR 2N4302	Q1-Q4	9-04733	
28	4	AMPLIFIER	A1-A4	67-0520-1	

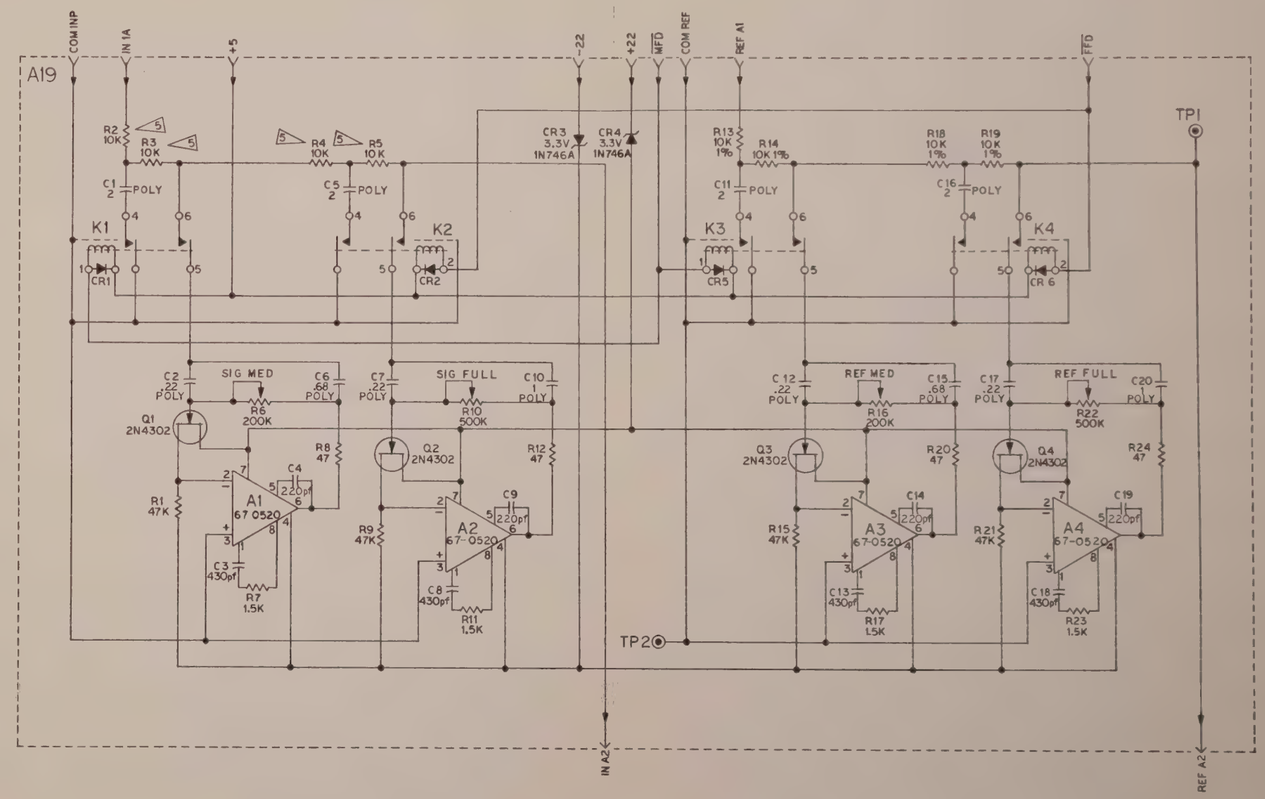
NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



5 FOR SCHEMATIC SEE 68-0738

R2-R5 FURNISHED AS PART OF 68-0506-1
5 REPLACEABLE AS A KIT ONLY SEE 68-5009-1
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A19
2. ALL CAPACITORS ARE IN µF
1. ALL RESISTORS ARE IN OHMS ±5% 1/4W

NOTES: UNLESS OTHERWISE SPECIFIED



6. DIODES ARE CIMRON P/N 7-95647

5 REPLACEABLE AS KIT ONLY, CIMRON P/N 68-0506-1 SEE ALSO 68-0738

4. TP3

A4,C20,CR6,R24,K4	NONE
LAST NUMBER USED	NUMBER NOT USED

3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A19
2. ALL CAPACITORS ARE IN uf
1. ALL RESISTORS ARE IN OHMS, ±5%, 1/4W

NOTES: UNLESS OTHERWISE SPECIFIED:

Filter.

6-55/56

ORIGINAL

COMPARATOR, ONE THOUSAND, AND TEN THOUSANDS DECODER ASSEMBLY 68-5008

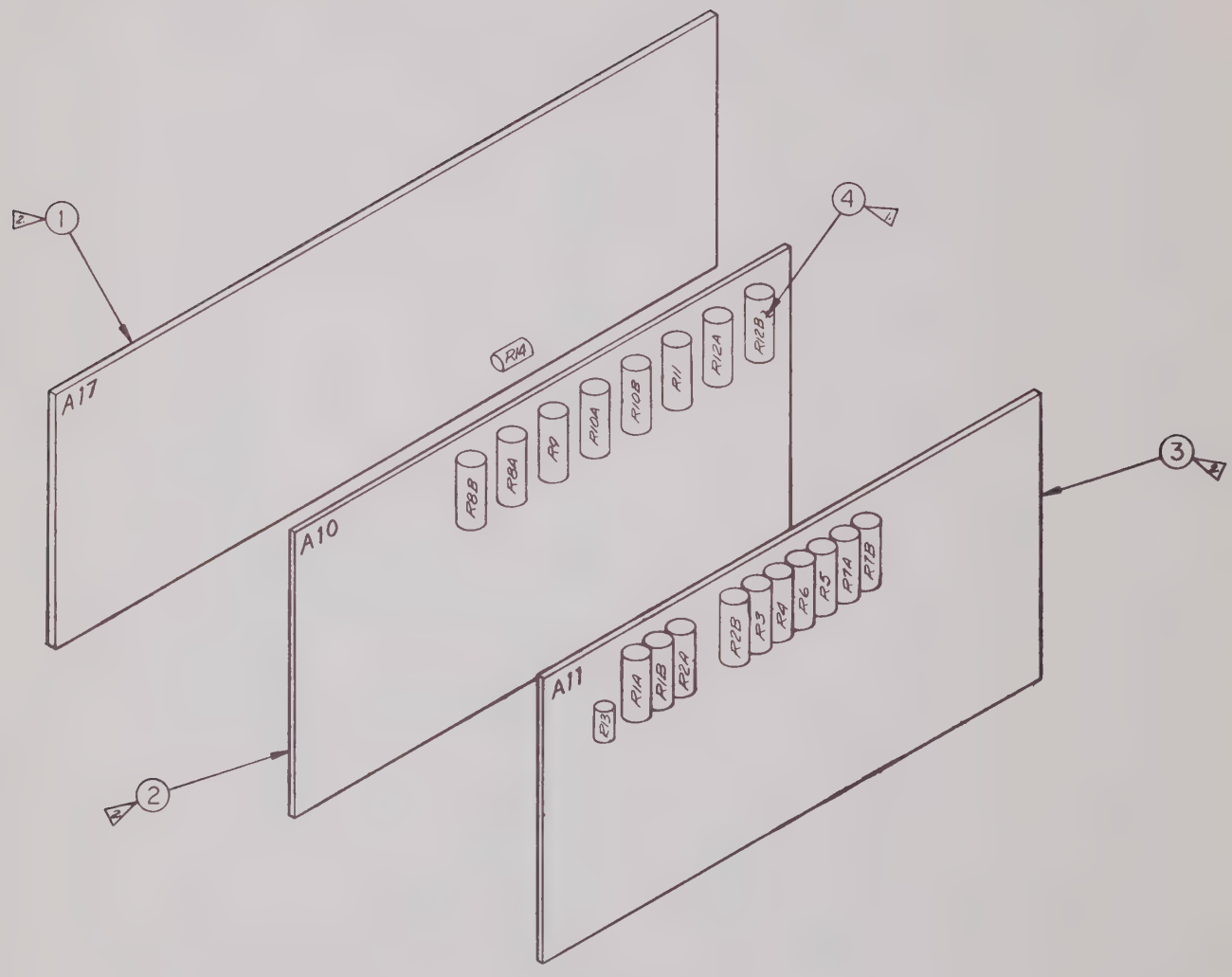
AND

COMPARATOR SUBASSEMBLY 68-6037

PARTS LIST

ASSEMBLY:	Comparator, 1K and 10K Decoder Assembly	SCHEMATIC NO.:		PART NO.: 68-5008
ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES	CIMRON PART NO.
1	1	COMPARATOR SUBASSEMBLY	A17	68-6037
2	1	1K DECODER SUBASSEMBLY	A10	67-6090
3	1	10K DECODER SUBASSEMBLY	A11	67-6091
4	1	RATIO RESISTOR SET	R1-R14	67-0513-1

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



2. SUB ASSEMBLY ITEMS 1 THRU 3 ARE REPLACEABLE AS A GROUP ONLY.

1. RESISTORS ARE REPLACEABLE AS A KIT ONLY.

NOTES: UNLESS OTHERWISE SPECIFIED

Figure 6-5. Comparator, One Thousand, and Ten Thousands Decoder Assembly.

PARTS LIST

ASSEMBLY: Comparator Sub Assembly SCHEMATIC NO.: 68-0737 PART NO.: 68-6037

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A17)	CIMRON PART NO.	
1	1	ETCHED CKT BD		68-7037	
2	1	AMPLIFIER	A1	0-05000	
3	2	CAP TANT 2.2 20V	C7, C9	1-57108	
4	1	CAP POLY CARB 0.68 50V	C11	1-57392	
5	1	CAP SIL MICA 10pF 500V	C1	1-57454	
6	1	CAP SIL MICA 22pF500V	C3	1-57463	
7	1	CAP SIL MICA 100pF 500V	C5	1-57469	
8	1	CAP CER DISC 0.1 10V	C6	1-57525	
9	4	CAP CER DISC 0.1 50V	C2, C4, C8, C10	1-57529	
10	1	CHOKE 100 μH	L1	1-90007	
11	3	RELAY REED R2191-1	K1, K2, K3	7-38228	
12	1	RELAY REED R2540-1	K6	7-38240	
13	1	RELAY REED R2527-1	K4	7-38241	
14	1	RELAY REED R2582-1	K5	7-38242	
15	1	RES COMP 56K 5% 1/2W	R27	7-41064	
16	1	RES COMP 10	R5	7-41219	
17	2	RES COMP 470	R17, R18	7-41239	
18	1	RES COMP 1K	R3	7-41243	
19	2	RES COMP 10K	R6, R8	7-41255	
20	4	RES COMP 100K	R23, R24, R25, R26	7-41267	
21	1	RES TIN OXIDE 1K 1% 1/4W	R12	7-46711	
22	1	RES TIN OXIDE 33.2K 1% 1/4W	R14	7-46714	
23	2	RES TIN OXIDE 100K 1% 1/4W	R10, R16	7-46716	
24	1	RES TIN OXIDE 66.5K 1% 1/4W	R19	7-46738	
25	1	RES TIN OXIDE 5.49K 1% 1/4W	R13	7-46768	
26	1	RES TIN OXIDE 9.09K 1% 1/4W	R1	7-46796	
27	1	RES TIN OXIDE 69.8K 1% 1/4W	R22	7-46835	
28	2	RES TIN OXIDE 365K 1% 1/4W	R2, R9	7-46837	
29	1	RES WW 10.94K 0.1% 1/4W	R34	7-47333	
30	1	RES WW 9.09K 0.1% 1/4W	R4	7-47348	
31	1	RES WW 100K 0.1% 1/4W	R37	7-47349	
32	1	RES WW VAR 10K	R35	7-54103	
33	1	RES WW VAR 200	R38	7-54215	
34	1	RES VAR 50K	R11	7-54283	
35	2	RES VAR 2K	R20, R21	7-54284	
36	2	RES VAR 10K	R30	7-54288	
37	4	DIODE FD300	CR1, CR2, CR3, CR6	7-95505	
38	1	DIODE ZENER 1N712	CR15	7-95611	

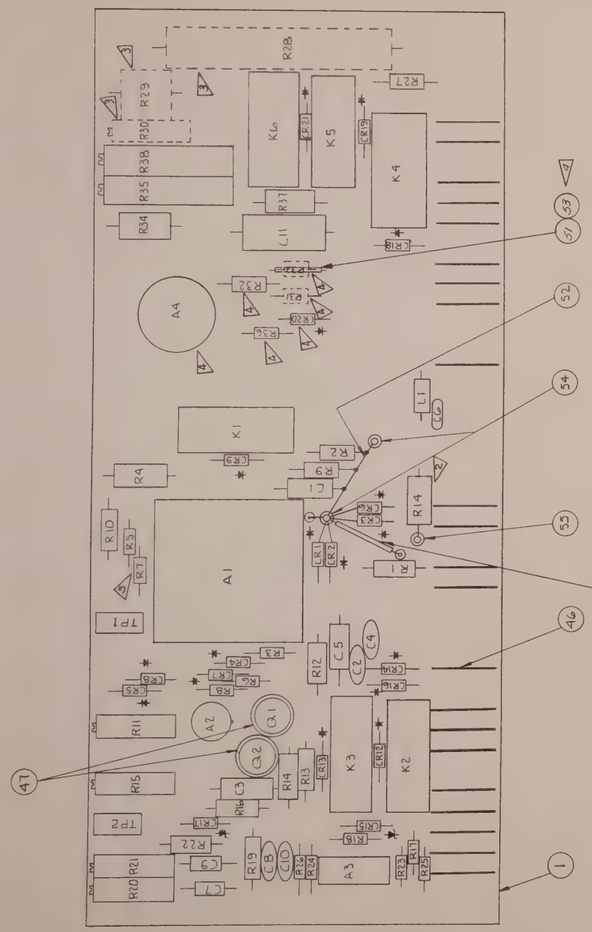
NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.

PARTS LIST

ASSEMBLY: Comparator Sub Assembly SCHEMATIC NO.: 68-0737 PART NO.: 68-6037

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A17)	CIMRON PART NO.	
39	2	DIODE ZENER 1N746A	CR14, CR16	7-95618	
40	1	DIODE ZENER 1N965A	CR17	7-95624	
41	10	DIODE 1N914	CR4, CR5, CR7, CR8, CR9, CR12, CR13, CR18, CR19, CR21	7-95647	
42	1	INT CKT SN72720 DUAL COMP	A3	7-96042	
43	1	AMPLIFIER 741A	A2	7-96073	
44	2	TRANSISTOR	Q1, Q2	9-04001	
45					
46	1	REF VOLTAGE MODULE	A4	68-0507	
47					
48	22	CONTACT ELECT		2-63904	
49	2	PAD, TRANS		5-07106	
50					
51	A/R	WIRE UNINSUL NO. 24 GAUGE		9-81024	
52	A/R	WIRE UNINSUL NO. 22 GAUGE		9-81022	
53	A/R	INSUL. TEFLON NO. 24 GAUGE		9-07724	
54	2	TEFLON STANDOFF		8-91113	
55	1	TEFLON STANDOFF		8-91114	
56	1	TEST POINT (BROWN)	TP1	5-19004	
57	1	TEST POINT (RED)	TP2	5-19002	

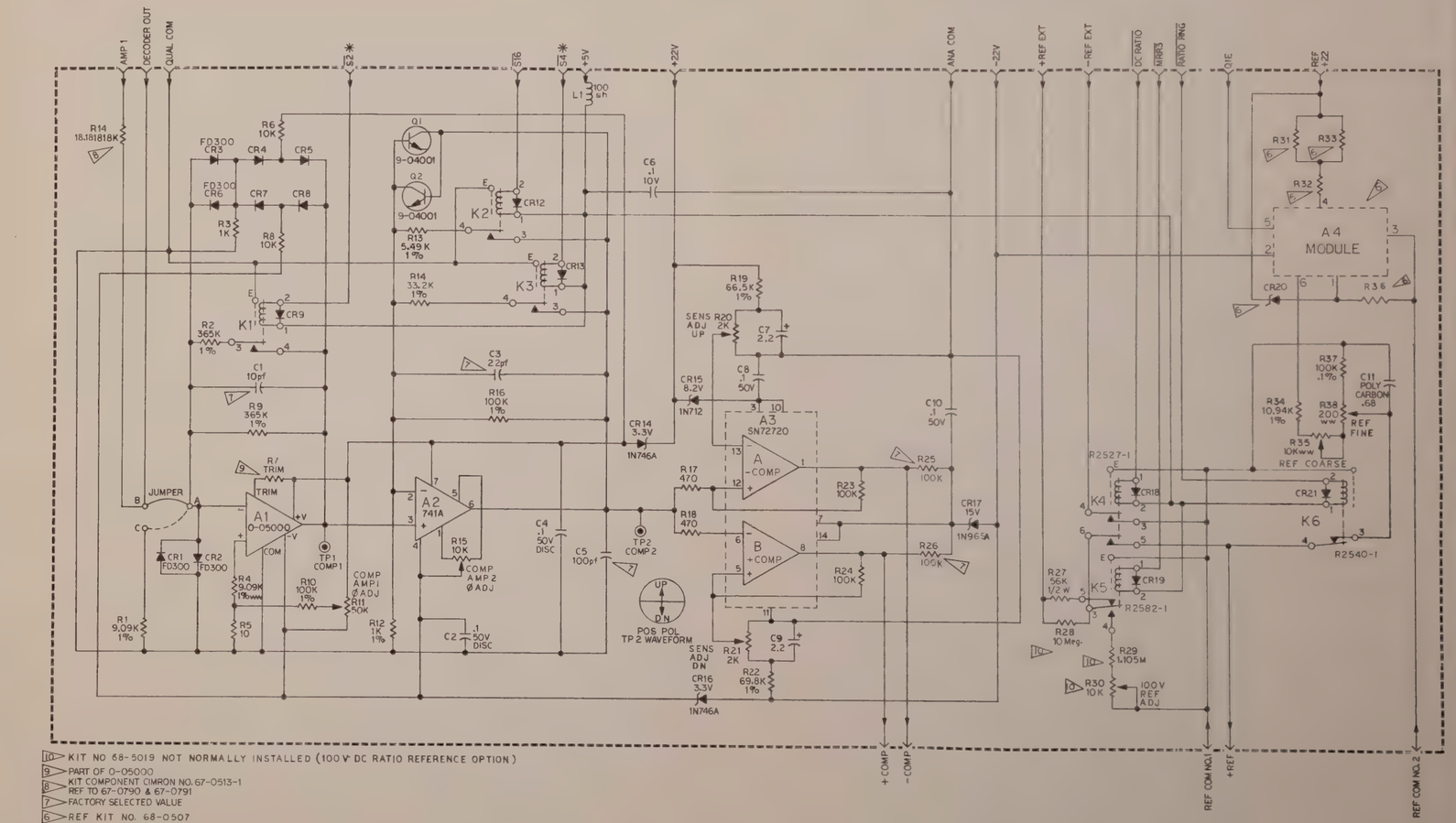
NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



PART OF O-05000
REF KIT 68-0507
R31 / R33 ITEMS 51 & 53 FACTORY SELECTED
68-5019 100V DC REFERENCE KIT NOT NORMALLY INSTALLED
R14 FURNISHED AS PART OF 67-0513-1 SEE 68-5008

1. PARTIAL DESIGNATOR SHOWN. FOR COMPLETE DESIGNATION PREFIX A17

NOTES: UNLESS OTHERWISE SPECIFIED.



10 KIT NO 68-5019 NOT NORMALLY INSTALLED (100 V DC RATIO REFERENCE OPTION)

9 PART OF O-05000
KIT COMPONENT CIMRON NO. 67-0513-1
REF TO 67-0790 & 67-0791

8 FACTORY SELECTED VALUE

7 REF KIT NO. 68-0507

6 5. UNMARKED DIODES ARE CIMRON P/N 7-95647

4. R38
A3, C11 CR21, K6, L1,
LAST NUMBER USED | NUMBER NOT USED

3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A17

2. ALL CAPACITORS ARE IN uf

1. ALL RESISTORS ARE IN OHMS, ±5%, 1/4W

NOTES: UNLESS OTHERWISE SPECIFIED:

Comparator.

6-63/64

REFERENCE AMPLIFIER

ASSEMBLY 68-6040

PARTS LIST

ASSEMBLY: Reference Amplifier SCHEMATIC NO.: 68-0740 PART NO.: 68-6040

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A20)	CIMRON PART NO.	
1	1	ETCHED CIRCUIT BOARD		68-7040	
2	18	CONTACT ELECT		2-63904	
3	2	INSULATOR, TRANSISTOR PAD		5-07106	
4					
5	3	AMPLIFIER	A3, A5, A6	0-05000	
6	1	AMPLIFIER	A2	0-05001	
7					
8	3	CAP TANT 22 15V	C1, C4, C13	1-57109	
9	3	CAP POLY STY 0.1 50V	C9, C11, C12	1-57397	
10	1	CAP POLY STY. 0.15 50V	C7	1-57398	
11	3	CAP SIL MICA 100pF 500V	C15-C17	1-57469	
12	2	CAP SIL MICA 200pF 500V	C10, C14	1-57474	
13	1	CAP SIL MICA 430pF 300V	C8	1-57481	
14	4	CAP CER DISC 0.1 50V	C2, C3, C5, C6	1-57529	
15					
16	1	COIL 100 μH	L1	1-90007	
17					
18	1	RELAY REED R2204-1	K3	7-38231	
19	1	RELAY REED R2540-1	K2	7-38240	
20	1	RELAY REED R2433-1	K1	7-38243	
21					
22	2	RES COMP 330 5% 1/2W	R1, R2	7-41037	
23	4	RES COMP 1K 5% 1/2W	R42, R43, R45, R46	7-41043	
24	3	RES COMP 10	R6, R14, R40	7-41219	
25	1	RES COMP 22	R9	7-41223	
26	1	RES COMP 1K	R25	7-41243	
27	1	RES COMP 1.5K	R7	7-41245	
28	3	RES COMP 10K	R19, R20, R22	7-41255	
29	2	RES COMP 47K	R3, R31	7-41263	
30	1	RES COMP 68K	R4	7-41265	
31	3	RES COMP 180K	R15, R28, R37	7-41270	
32	1	RES COMP 470K	R23	7-41275	
33	1	RES TIN OXIDE 100 1%	R27	7-46707	
34	1	RES TIN OXIDE 27.4K 1%	R5	7-46791	
35	2	RES WW 5K 1%	R18, R39	7-47190	
36	1	RES WW 200K 0.05% 5PPM 1/4W	R29	7-47300	
37	1	RES WW 18.2K 0.05% 5PPM 1/4W	R32	7-47312	
38	1	RES WW 19.5K 0.05% 5PPM 1/4W	R33	7-47327	

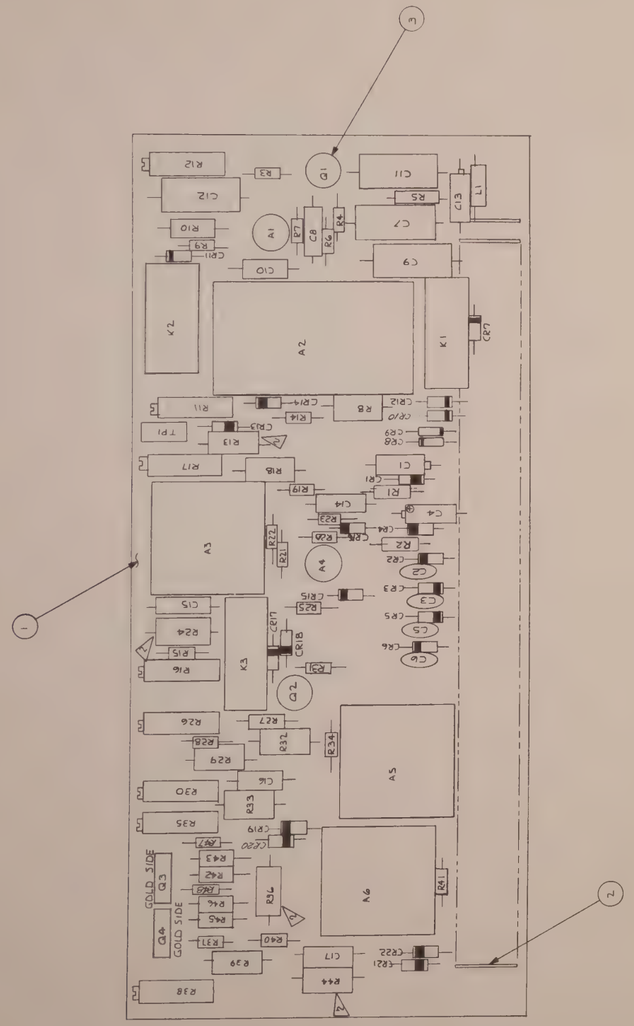
NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.

PARTS LIST

ASSEMBLY: Reference Amplifier SCHEMATIC NO.: 68-0740 PART NO.: 68-6040

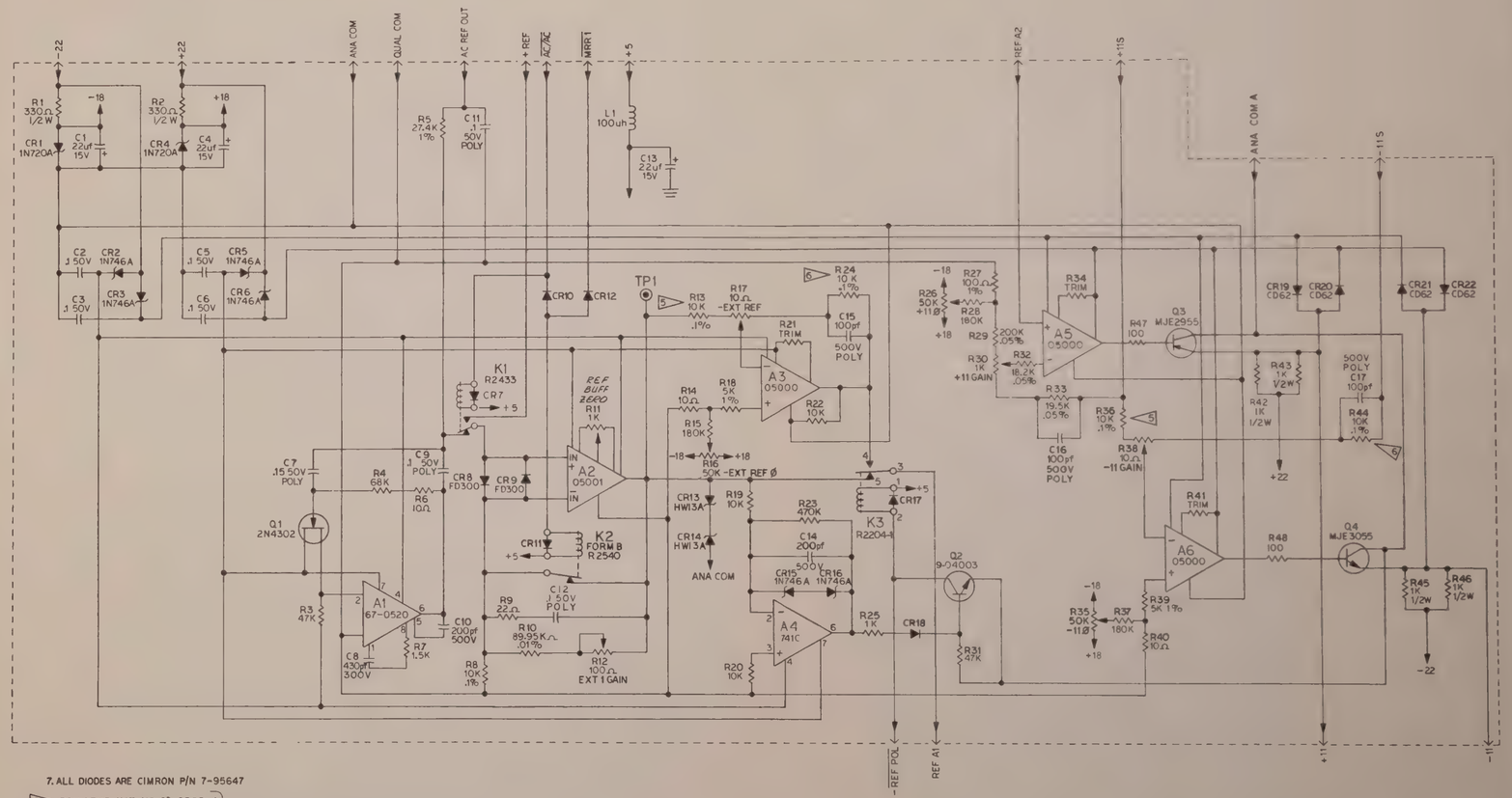
ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A20)	CIMRON PART NO.	
39	1	RES WW 10K 0.1% 5PPM 1/4W	R8	7-47358	
40	1	RES WW 89.95K 0.01% 5PPM	R10	7-47369	
41	3	RES VAR 50K	R16, R26, R35	7-54283	
42	2	RES VAR 10	R17, R38	7-54286	
43	2	RES VAR 1K	R11, R30	7-54305	
44	1	RES VAR 100	R12	7-54309	
45	1	PRINTED CIRCUIT TEST JACK (BROWN)	TP1	5-19004	
46	2	DIODE FD300	CR8, CR9	7-95505	
47	4	DIODE CD62	CR19-CR22	7-95507	
48	6	DIODE, ZENER 1N746A	CR2, CR3, CR5, CR6, CR15, CR16	7-95618	
49	2	DIODE, ZENER 1N720A	CR1, CR4	7-95629	
50	6	DIODE 1N914	CR7, CR10-CR12, CR17, CR18	7-95647	
51	2	DIODE, ZENER HW13A	CR13, CR14	7-95673	
52					
53	1	AMPLIFIER 741C	A4	7-96060	
54					
55	1	TRANSISTOR NPN CIMRON SPEC 2N2222	Q2	9-04003	
56	1	TRANSISTOR 2N4302	Q1	9-04733	
57	1	TRANSISTOR MJE3055	Q4	9-04782	
58	1	TRANSISTOR MJE2955	Q3	9-04827	
59					
60	1	AMPLIFIER	A1	67-0520	
61	2	RES KIT	(R8, R13, R36) (R24,R44)	68-0505-1	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



NOTES: UNLESS OTHERWISE SPECIFIED

3. TRIM RESISTORS R21, R34, R41 ARE SUPPLIED WITH AMPLIFIER A3, A5, A6
2. [R13] & [R34] & [R24-R44] ARE 2.68-0505 RATIOED RESISTOR KITS AND SHOULD NOT BE INTERCHANGED
1. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A20



7. ALL DIODES ARE CIMRON P/N 7-95647

6 RESISTOR KIT NO. 68-0505-1
5 RESISTOR KIT NO. 68-0505-1
} THESE KITS ARE NOT INTERCHANGEABLE

4. R48

A6, C17, CR22, K3, L1, Q4	
LAST NUMBER USED	NUMBER NOT USED

3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A20
2. ALL CAPACITORS ARE IN uf
1. ALL RESISTORS ARE IN OHMS, ±5%, 1/4W

NOTES: UNLESS OTHERWISE SPECIFIED:

Reference Amplifier.

6-69/70

ORIGINAL

UNITS DECADE AND CONTROL LOGIC

ASSEMBLY 68-6046

PARTS LIST

ASSEMBLY: Units Decade and Control Logic SCHEMATIC NO.: 68-0746 PART NO.: 68-6046

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A6)	CIMRON PART NO.	
1	1	ETCHED CIRCUIT BOARD		68-7046	
2	1	CAP CER DISC 0.1 10V	C1	1-57525	
3	1	CAP MOLDED MYLAR 0.027 50V 10%	C2	1-57388	
4	2	CAP. FACTORY SELECTED VALUE	C3, C7		
5	1	CAP. M PAP. 0.01 50V	C4	1-57323	
6	1	CAP. TANT 0.47 35V	C5	1-57111	
7	1	CAP. MET MYLAR 0.047 100V	C6	1-57378	
8	1	CAP. CER DISC 330pF 1000V, NOM. VAL	C13	1-57479	
9	3	CAP. M PAP. 0.33 50V	C8, C10, C11	1-57328	
10	1	CAP. TANT. 10 20V	C9	1-57112	
11	1	CAP. ELECT. 50 50V	C12	1-57257	
12	5	TRANSISTOR NPN CIMRON SPEC 2N2222	Q1, Q2, Q3, Q4, Q6	9-04003	
13	1	TRANSISTOR UNIJUNCTION 2N4852	Q5	9-04402	
14	9	RES. COMP. 3.6K	R1, R2, R3, R4, R10, R11, R13, R25, R26	7-41300	
15	3	RES. COMP. 330	R5, R6, R9	7-41237	
16	1	RES. COMP. 270	R7	7-41236	
17	2	RES. COMP. 100	R8, R22	7-41231	
18	2	RES. COMP. 4.7K	R12, R16	7-41251	
19	2	RES. COMP. 100K	R14, R15	7-41267	
20	1	RES. COMP. 22	R17	7-41223	
21	2	RES. COMP. 2.2K	R18, R24	7-41247	
22	1	RES. COMP. 1K	R19	7-41243	
23	1	RES. COMP. 150K	R20	7-41269	
24	1	RES. COMP. 12K	R21	7-41256	
25	15	INT. CIRCUIT 846	ZA1, ZA2, ZA7, ZA8, ZA11, ZA14, ZA15, ZB1, ZB2, ZB3, ZB4, ZB5, ZB6, ZB9, ZB12	7-96008	
26	6	INT. CIRCUIT 845	ZA3, ZA4, ZA5, ZA6, ZA10 ZA13	7-96007	
27	3	INT. CIRCUIT 832	ZA9, ZA12, ZB11	7-96004	
28	3	INT. CIRCUIT 830	ZB7, ZB10, ZB13	7-96002	
29	1	INT. CIRCUIT 862	ZB8	7-96010	
30	A/R	WIRE NO. 24 GAUGE		9-81024	
31	A/R	TUBING, NATURAL NO. 24		9-07724	

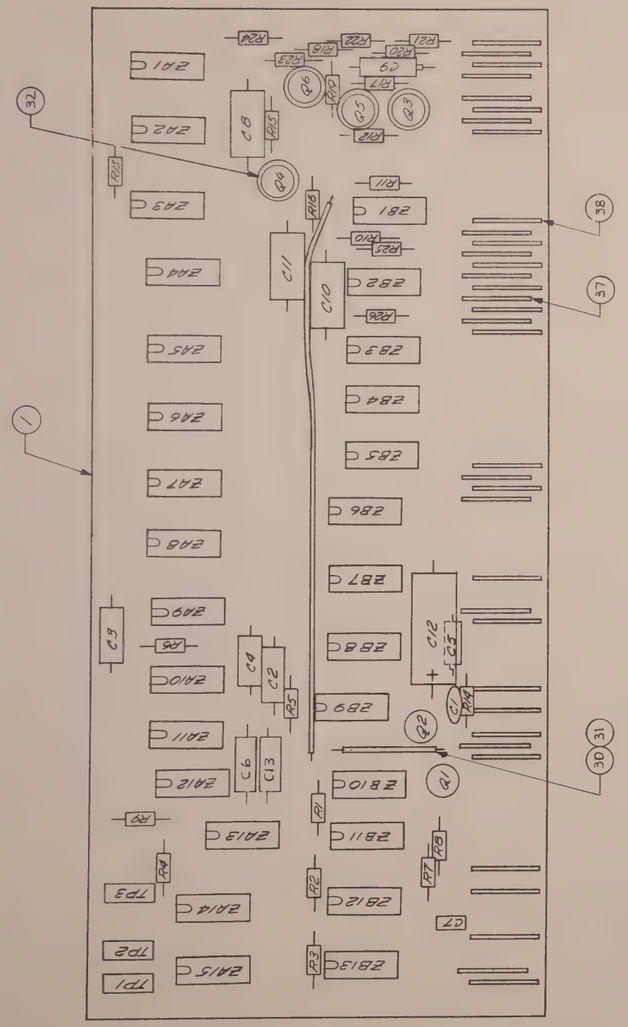
NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.

PARTS LIST

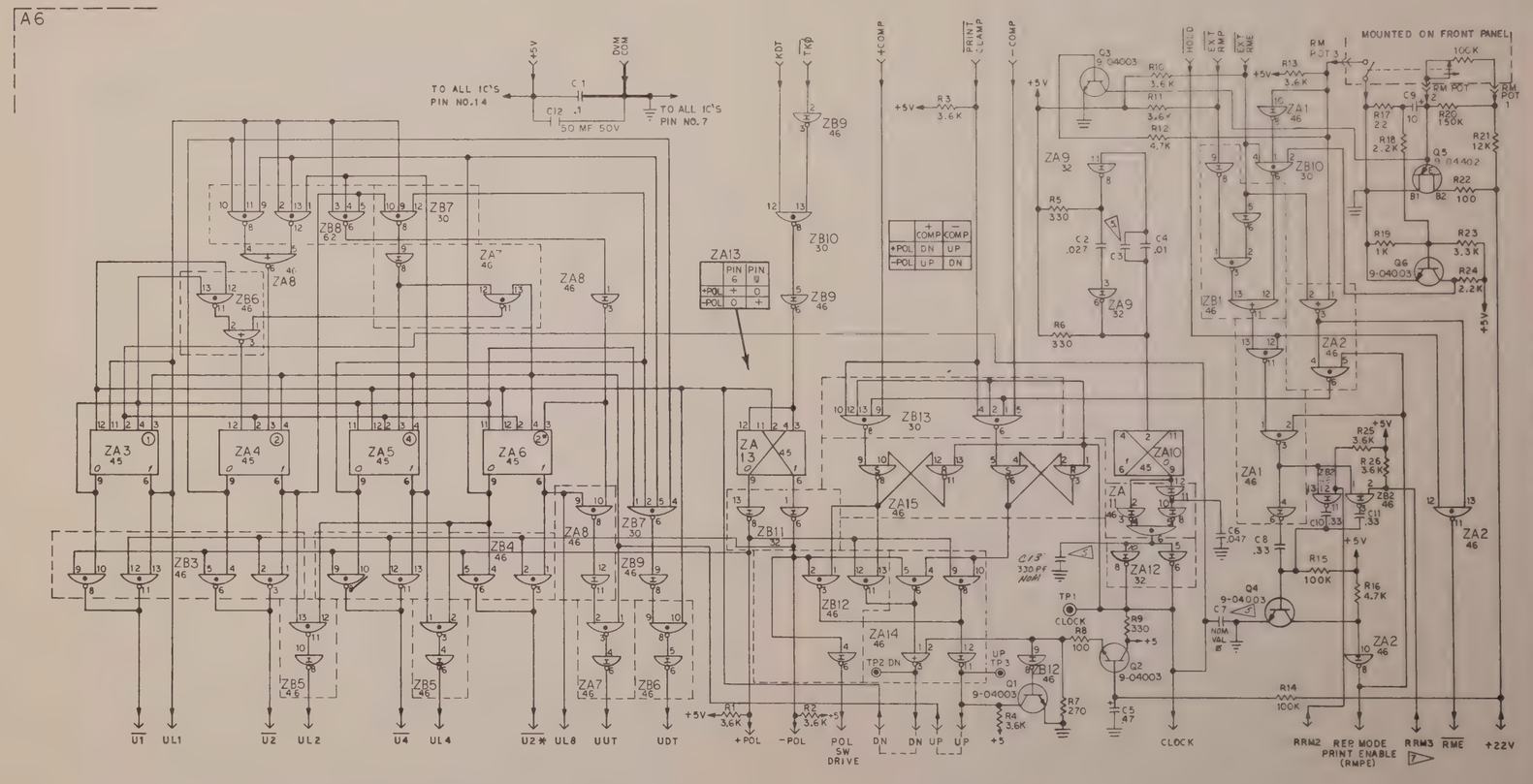
ASSEMBLY: Units Decade & Control Logic SCHEMATIC NO.: 68-0746 PART NO.: 68-6046

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 6)	CIMRON PART NO.	
32	6	TRANSISTOR PAD		5-07106	
33	1	RES. COMP. 3.3K	R23	7-41249	
34	1	TEST JACK, BROWN	TP1	5-19004	
35	1	TEST JACK, RED	TP2	5-19002	
36	1	TEST JACK, ORANGE	TP3	5-19006	
37	14	CONTACT ELECTRICAL (UPPER)		2-63907	
38	22	CONTACT ELECTRICAL (LOWER)		2-63904	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



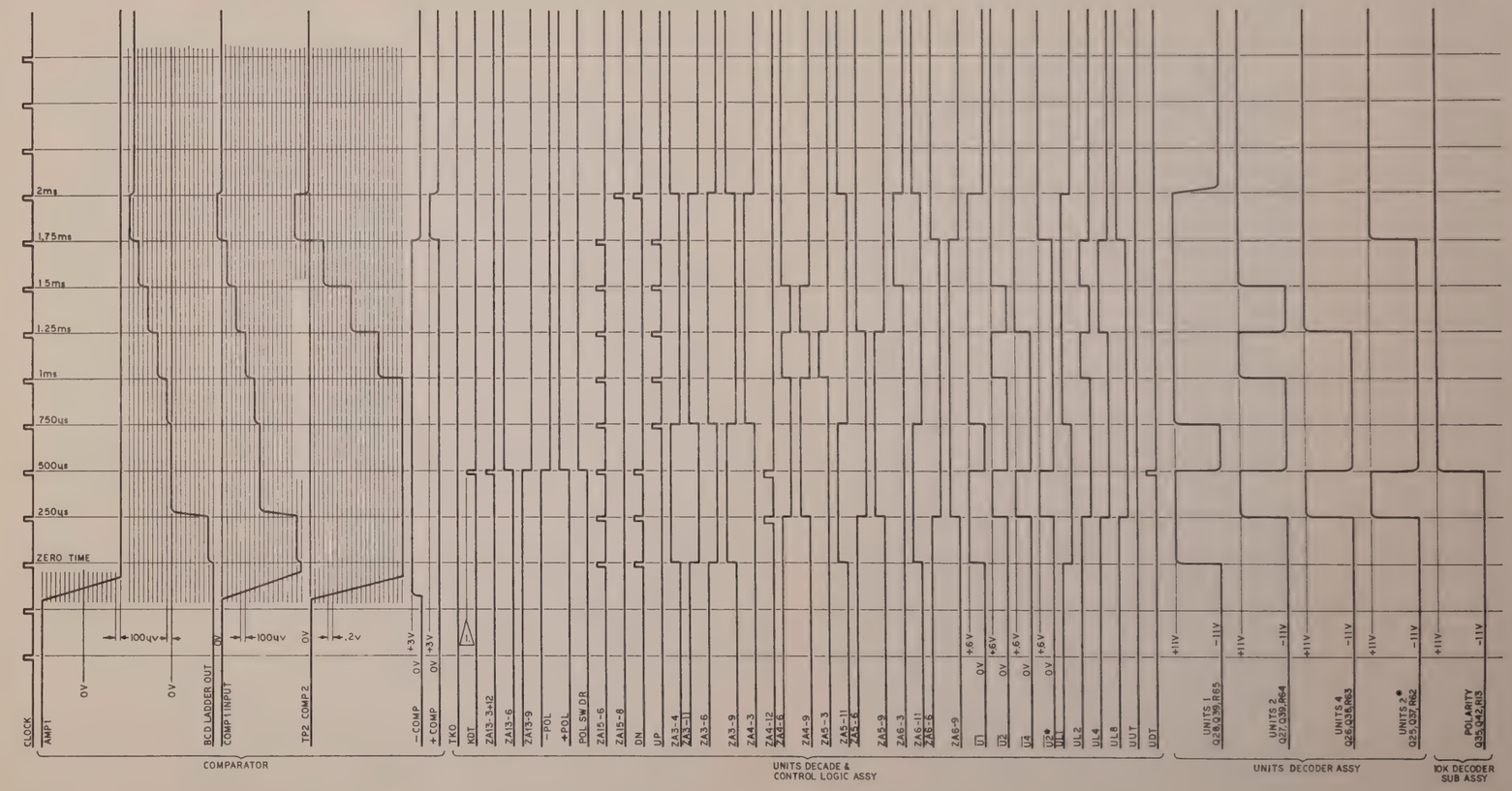
NOTES:
UNLESS OTHERWISE SPECIFIED:
1. FOR SCHEMATIC DIAGRAM SEE 69-0746
2. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A6



NOTES: UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ARE IN OHMS, ±5%, ¼W
2. ALL CAPACITORS ARE IN μF
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A6
4. C13, R26, Q6, TP3. | NONE
   LAST NUMBER USED | NUMBER NOT USED
5. FACTORY SELECTED VALUE
   ZA15, ZB13
6. ALL DIODES ARE CIMRON P/N 7-95647
7. AVAILABLE ONLY WHEN NON-BUFFERED REMOTE ASSY. INSTALLED

Units Decade and Control Logic.

6-75/76



2. INPUT VOLTAGE IS −.0009 SWITCHED TO +.0008

1 UNLESS OTHERWISE SPECIFIED AMPLITUDE IS 5V

Voltage Change Timing Diagram.

6-77/78

ORIGINAL

TENS AND HUNDREDS DECADE

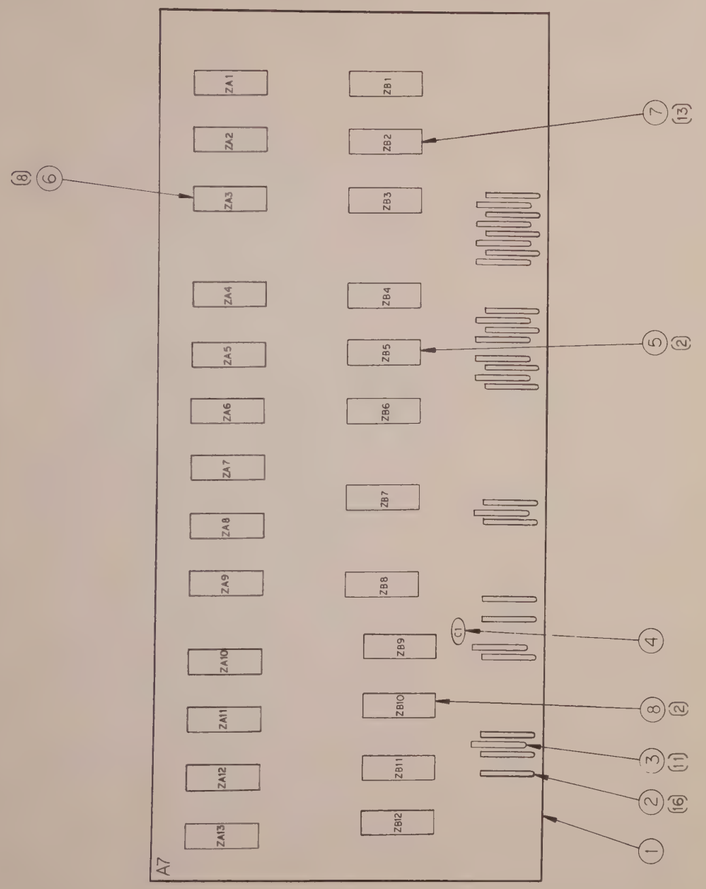
ASSEMBLY 67-6087

PARTS LIST

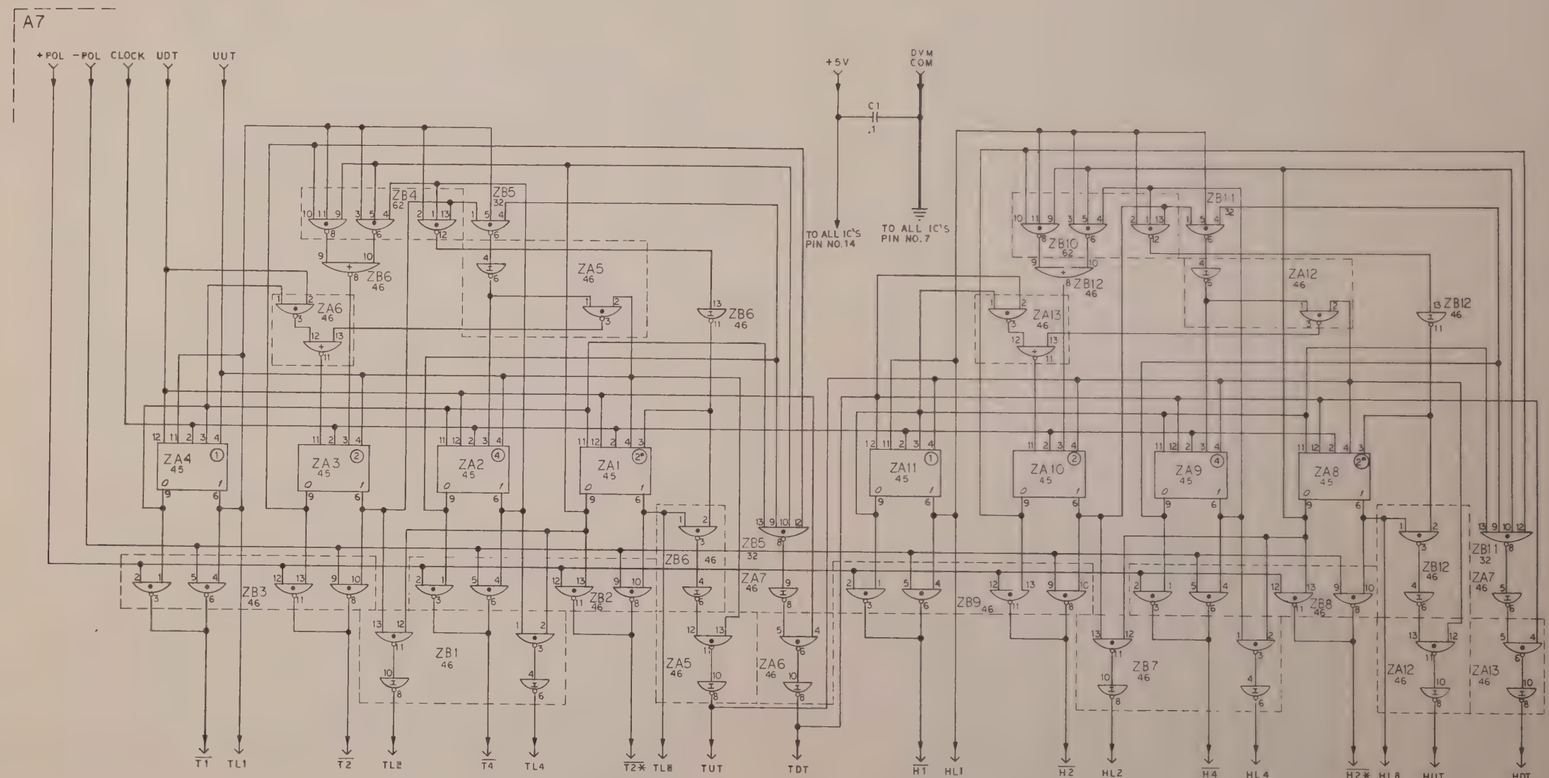
ASSEMBLY: Tens and Hundreds Decade SCHEMATIC NO.: 67-0787 PART NO.: 67-6087

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 7)	CIMRON PART NO.	
1	1	CKT BD – ETCHED		67-7087	
2	16	CONTACT – ELECT LOWER		2-63904	
3	11	CONTACT – ELECT UPPER		2-63907	
4	1	CAP CER DISC 0.1 10V	C1	1-57525	
5	2	IC DUAL BUFFER 4 INPUT	ZB5, ZB11	7-96004	
6	8	IC CLOCKED F/F	ZA1-ZA4, ZA8-ZA11	7-96007	
7	13	IC QUAD 2 INPUT GATE	ZA5-ZA7, ZA12, ZA13, ZB1-ZB3, ZB6-ZB9, AB12	7-96008	
8	2	IC TRIPLE 3 INPUT GATE	ZB4, ZB10	7-96010	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A7
2. ALL CAPACITORS ARE IN MF
1. ALL RESISTORS ARE IN OHMS, ±5%, ¼W
NOTES: UNLESS OTHERWISE SPECIFIED.



4. C1,ZA13, ZB12, | NONE
LAST NUMBER USED | NUMBER NOT USED
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A7
2. ALL CAPACITORS ARE IN MF
1. ALL RESISTORS ARE IN OHMS ±5% ¼W
NOTES: UNLESS OTHERWISE SPECIFIED.

Tens and Hundreds Decade.

6-81/82

ORIGINAL

ONE THOUSAND AND TEN THOUSAND DECADE

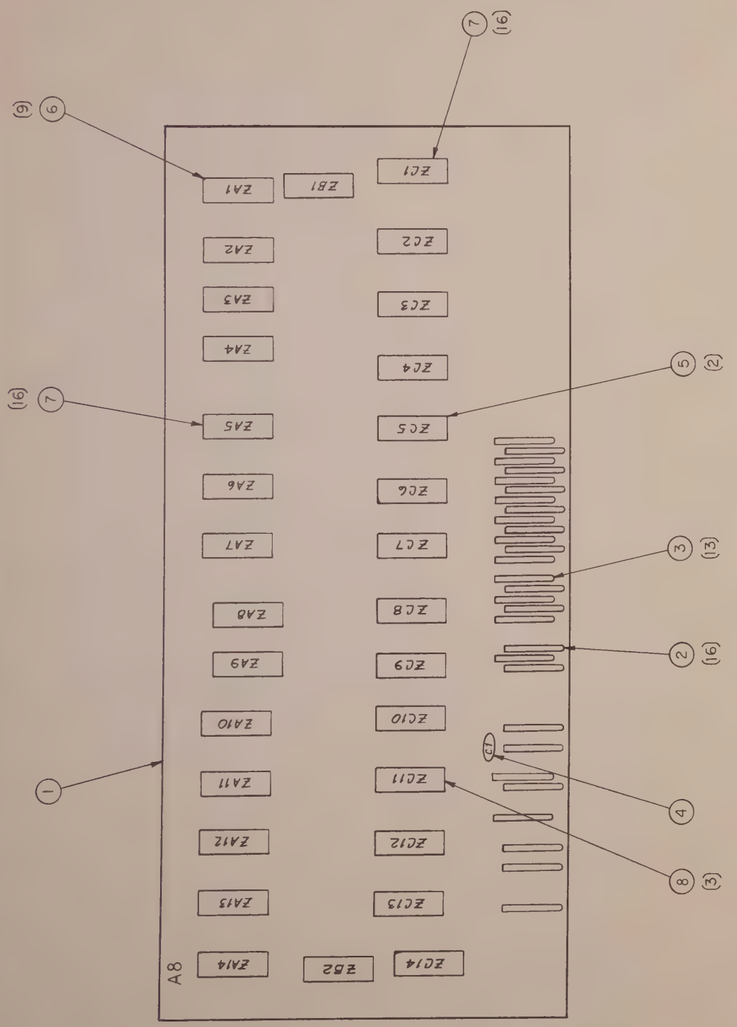
ASSEMBLY 67-6088

PARTS LIST

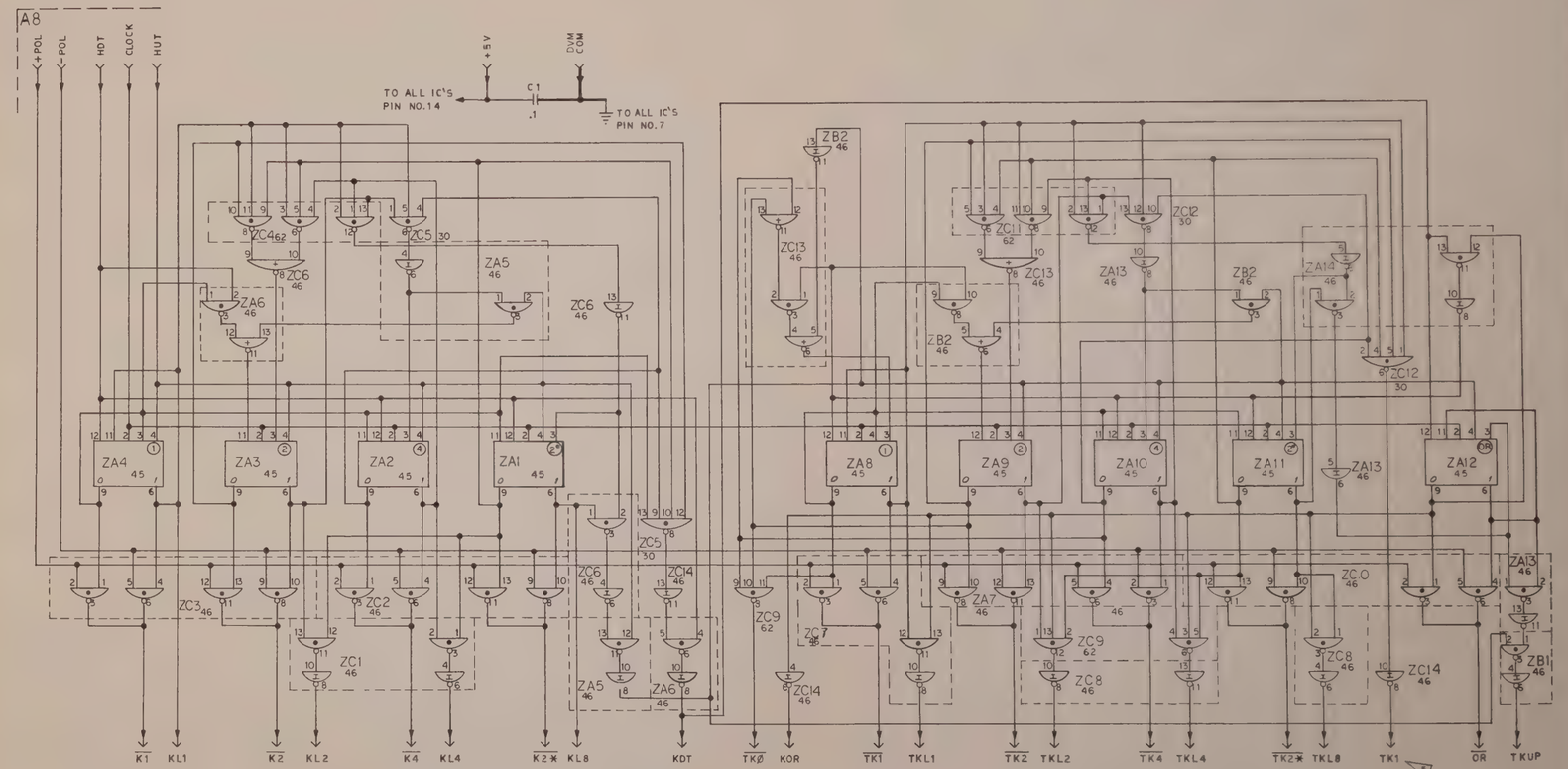
ASSEMBLY: One Thousand and Ten Thousand Decade	SCHEMATIC NO.: 67-0788	PART NO.: 67-6088

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 8)	CIMRON PART NO.	
1	1	CIRCUIT BD – ETCHED		67-7088	
2	16	CONTACT, ELECT (LOWER)		2-63904	
3	13	CONTACT, ELECT (UPPER)		2-63907	
4	1	CAP CER DISC 0.1 10V	C1	1-57525	
5	2	IC, DUAL 4 INPUT GATE	ZC5, ZC12	7-96002	
6	9	IC CLOCK F/F	ZA1-ZA4, ZA8-ZA12	7-96007	
7	16	IC QUAD 2 INPUT GATE	ZA5-ZA7, ZA13, ZA14, ZB1, ZB2, ZC1-ZC3, ZC6-ZC8, ZC10, ZC13, ZC14	7-96008	
8	3	IC TRIPLE, 3 INPUT GATE	ZC4, ZC9, ZC11	7-96010	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS, ±5%, ¼W
2. ALL CAPACITORS ARE IN MF
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A8



NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS, ±5%, ¼W
2. ALL CAPACITORS ARE IN MF
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A8
   LAST NUMBER USED | NUMBER NOT USED
4. C1, ZA14, ZB2, ZC14 | NONE
5. FOR SPECIAL APPLICATIONS ONLY

One Thousand and Ten Thousand Decade.

6-85/86

UNITS, TENS, AND HUNDREDS DECODER

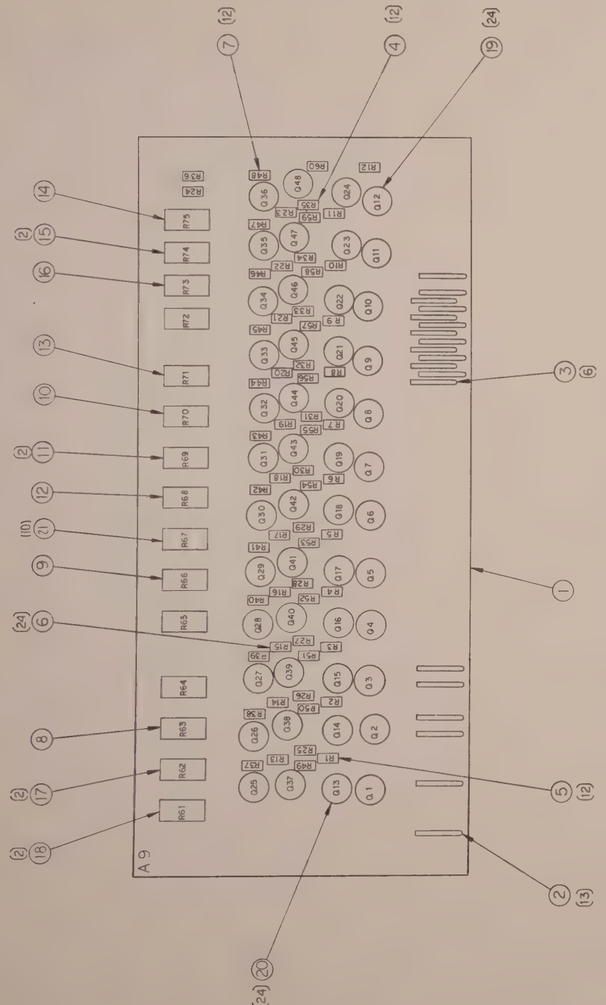
ASSEMBLY 67-6089

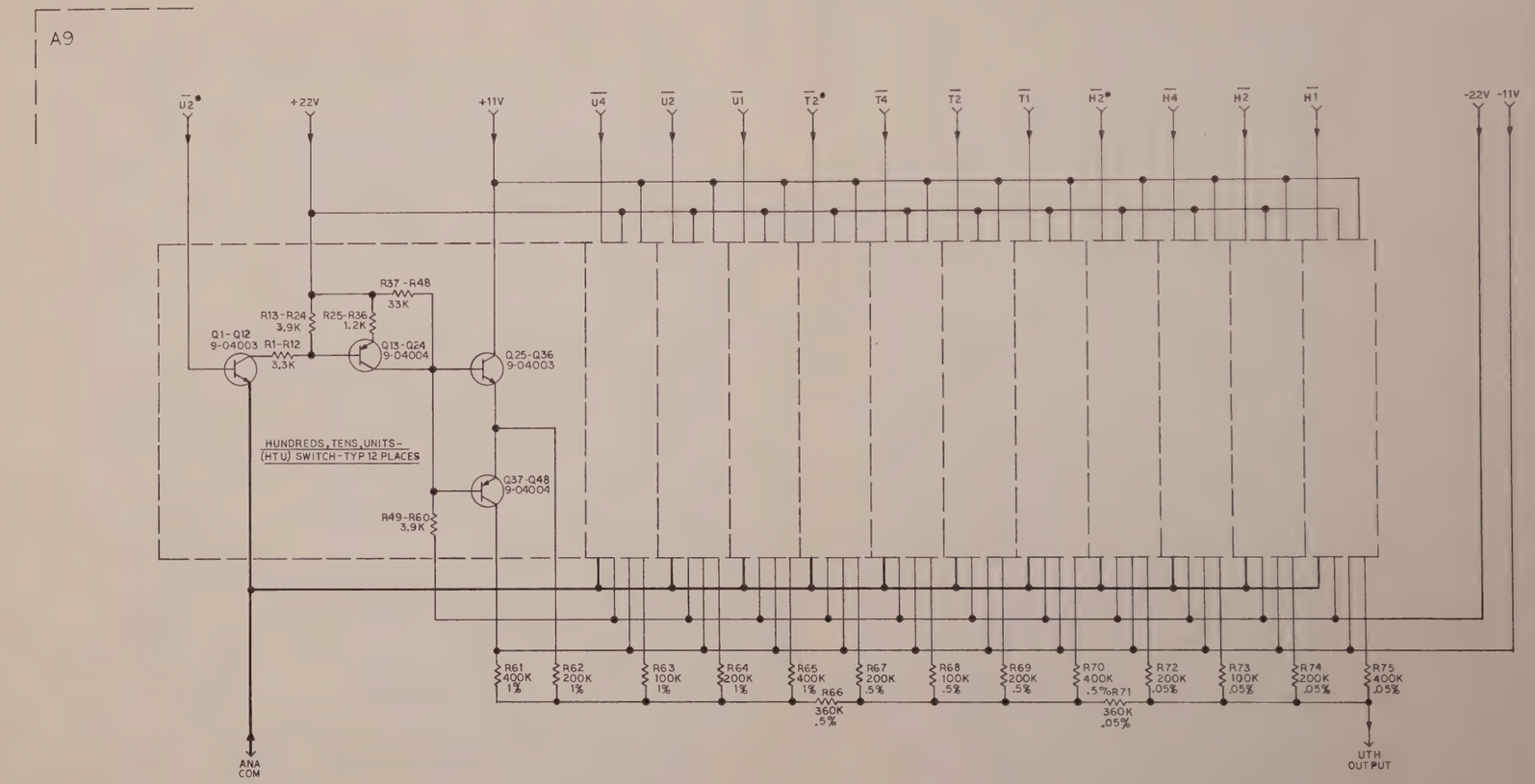
PARTS LIST

ASSEMBLY: Units, Tens, and Hundreds Decoder	SCHEMATIC NO.: 67-0789	PART NO.: 67-6089

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 9)	CIMRON PART NO.	
1	1	CIRCUIT BD – ETCHED		67-7089	
2	13	CONTACT ELECT – LOWER		2-63904	
3	6	CONTACT ELECT – UPPER		2-63907	
4	12	RES COMP 1.2K	R25-R36	7-41244	
5	12	RES COMP 3.3K	R1-R12	7-41249	
6	24	RES COMP 3.9K	R13-R24, R49-R60	7-41250	
7	12	RES COMP 33K	R37-R48	7-41261	
8	1	RES WW 100K 1%	R63	7-47264	
9	1	RES WW 360K 0.5%	R66	7-47294	
10	1	RES WW 400K 0.5%	R70	7-47295	
11	2	RES WW 200K 0.5%	R67, R69	7-47296	
12	1	RES WW 100K 0.5%	R68	7-47297	
13	1	RES WW 360K 0.05%	R71	7-47298	
14	1	RES WW 400K 0.05%	R75	7-47299	
15	2	RES WW 200K 0.05%	R72, R74	7-47300	
16	1	RES WW 100K 0.05%	R73	7-47301	
17	2	RES WW 200K 1%	R62, R64	7-47302	
18	2	RES WW 400K 1%	R61, R65	7-47303	
19	24	TRANSISTOR NPN	Q1-Q12, Q25-Q36	9-04003	
20	24	TRANSISTOR PNP	Q13-Q24, Q37-Q48	9-04004	
21	10	STANDOFF		8-91113	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.





3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A3
2. ALL CAPACITORS ARE IN MF
1. ALL RESISTORS ARE IN OHMS, ±5%, ¼W
NOTES: UNLESS OTHERWISE SPECIFIED

4. Q48, R75 | NONE
LAST NUMBER USED | NUMBER NOT USED
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A9
2. ALL CAPACITORS ARE IN MF
1. ALL RESISTORS ARE IN OHMS, ±5%, ¼W
NOTES: UNLESS OTHERWISE SPECIFIED:

Units, Tens, and Hundreds Decoder.

6-89/90

ORIGINAL

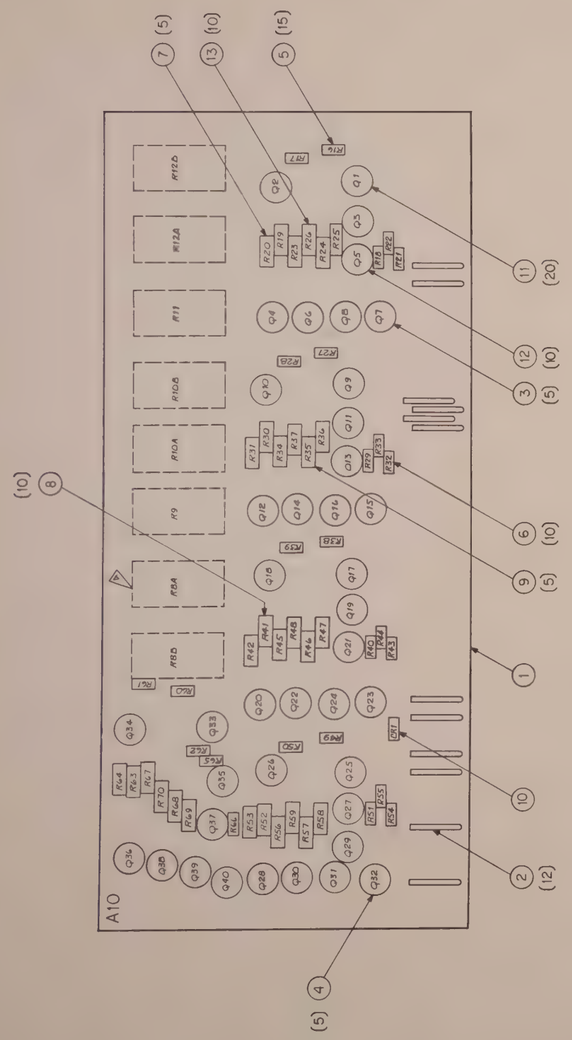
ONE THOUSAND DECODER

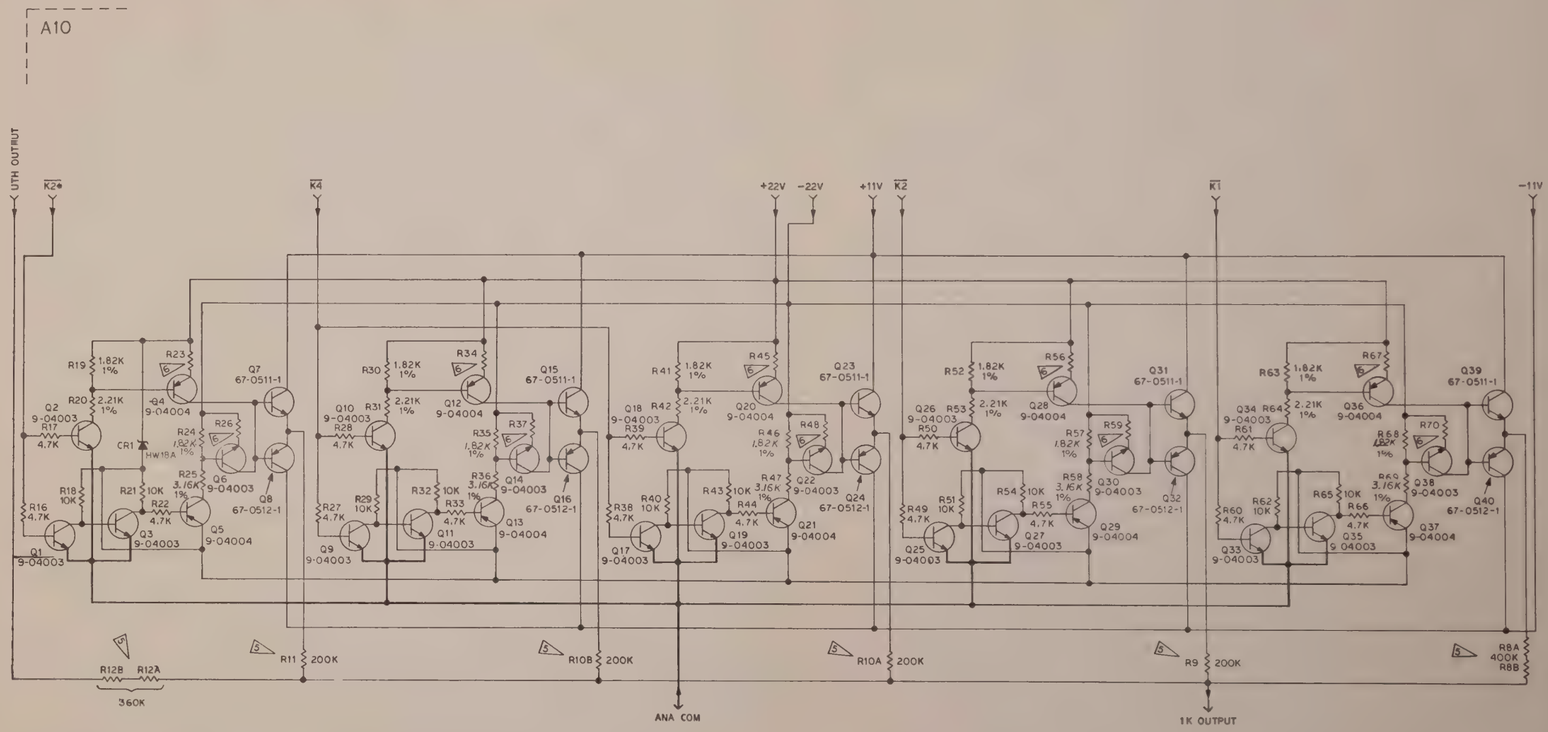
SUBASSEMBLY 67-6090

PARTS LIST

ASSEMBLY:	One Thousand Decoder Subassembly	SCHEMATIC NO.: 67-0790	PART NO.: 67-6090	
ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 10)	CIMRON PART NO.
1	1	CKT BD – ETCHED		67-7090
2	12	CONTACT ELEC		2-63904
3	5	TRANSISTOR NPN	Q7, Q15, Q23, Q31, Q39	67-0511-1
4	5	TRANSISTOR PNP	Q8, Q16, Q24, Q32, Q40	67-0512-1
5	15	RES COMP 4.7K	R16, R17, R22, R27, R28, R33, R38, R39, R44, R49, R50, R55, R60, R61, R66	7-41251
6	10	RES COMP 10K	R18, R21, R29, R32, R40, R43, R51, R54, R62, R65	7-41255
7	5	RES T.O. 2.21K 1%	R20, R31, R42, R53, R64	7-46710
8	10	RES T.O. 1.82K 1%	R19, R24, R30, R35, R41, R46, R52, R57, R63, R68	7-46731
9	5	RES T.O. 3.16K 1%	R25, R36, R47, R58, R69	7-46850
10	1	DIODE	CR1	7-95676
11	20	TRANSISTOR NPN	Q1-Q3, Q6, Q9-Q11, Q14, Q17-Q19, Q22, Q25-Q27, Q30, Q33-Q35, Q38	9-04003
12	10	TRANSISTOR PNP	Q4, Q5, Q12, Q13, Q20, Q21, Q28, Q29, Q36, Q37	9-04004
13	10	RES T.O., FACT. SEL. VALUE	R23, R26, R34, R37, R45, R48, R56, R59, R67, R70	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.





NOTES:
1. ALL RESISTORS ARE IN OHMS, ±5%, ¼W UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS ARE IN MF.
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A10.
4. CR1, Q40, R20 | R1-R7, R13-R15
   LAST NUMBER USED | NUMBER NOT USED
5. R8 - R12 FURNISHED AS PART OF 67-0513-1 SEE 67-5007

NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS, ±5%, ¼W
2. ALL CAPACITORS ARE IN MF
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A10

5 FURNISHED AS PART OF 67-0513-1

6 FACTORY SELECTED VALUE

One Thousand Decoder.

6-93/94

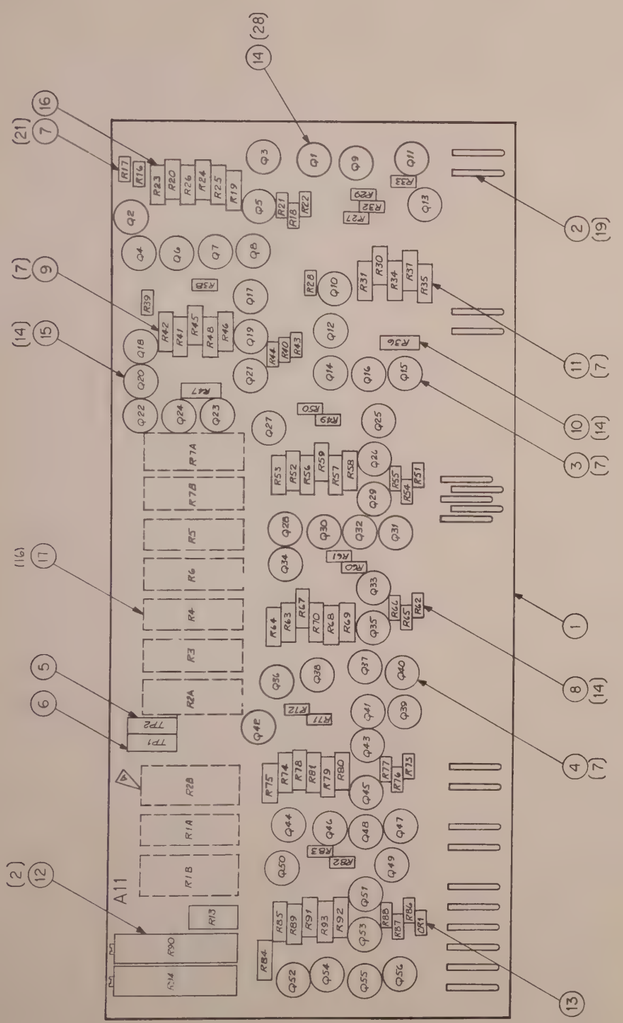
TEN THOUSAND DECODER

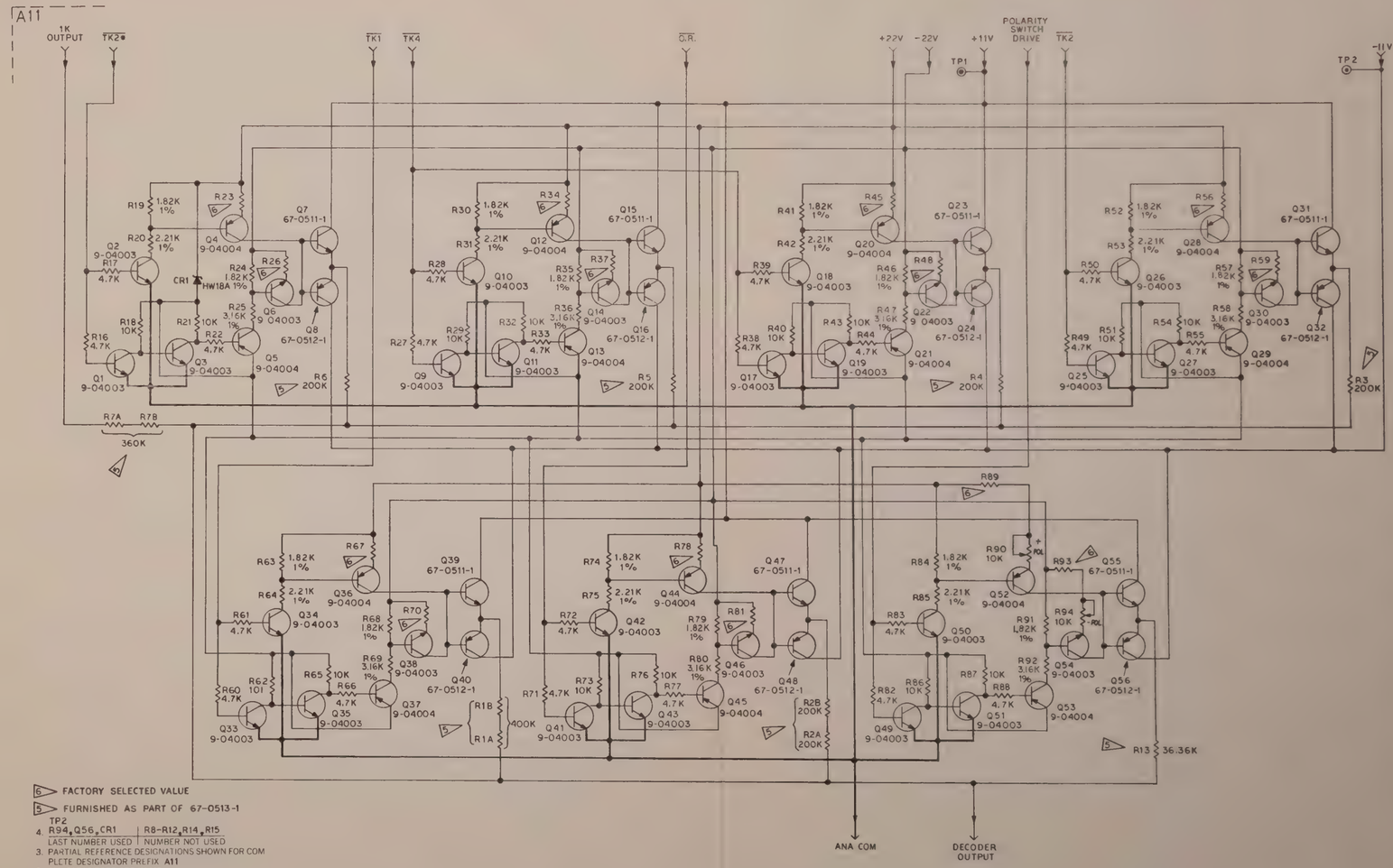
SUBASSEMBLY 67-6091

PARTS LIST

ASSEMBLY: Ten Thousand Decoder Subassembly		SCHEMATIC NO.: 67-0791		PART NO.: 67-6091	
ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 11)	CIMRON PART NO.	
1	1	CKT BD – ETCHED		67-7091	
2	19	CONTACT ELECT		2-63904	
3	7	TRANSISTOR NPN	Q7, Q15, Q23, Q31, Q39, Q47, Q55	67-0511-1	
4	7	TRANSISTOR PNP	Q8, Q16, Q24, Q32, Q40, Q48, Q56	67-0512-1	
5	1	TEST POINT JACK (RED)	TP2	5-19002	
6	1	TEST POINT JACK (BROWN)	TP1	5-19004	
7	21	RES COMP 4.7K	R16, R17, R22, R27, R28, R33, R38, R39, R44, R49, R50, R55, R60, R61, R66, R71, R72, R77, R82, R83, R88	7-41247	
8	14	RES COMP 10K	R18, R21, R29, R32, R40, R43, R51, R54, R62, R65, R73, R76, R86, R87	7-41255	
9	9	RES T.O. 2.21K 1%	R20, R31, R42, R53, R64, R75, R85	7-46710	
10	14	RES T.O. 1.82K 1%	R19, R24, R30, R35, R41, R46, R52, R57, R63, R68, R74, R79, R84, R91	7-46731	
11	7	RES T.O. 3.16K 1%	R25, R36, R47, R58, R69, R80, R92	7-46850	
12	2	RES VAR 10K	R90, R94	7-54103	
13	1	DIODE	CR1	7-95676	
14	28	TRANSISTOR NPN	Q1, Q2, Q3, Q6, Q9, Q10, Q11, Q14, Q17, Q18, Q19, Q22, Q25, Q26, Q27, Q30, Q33, Q34, Q35, Q38, Q41, Q42, Q43, Q46, Q49, Q50, Q51, Q54	9-04003	
15	14	TRANSISTOR PNP	Q4, Q5, Q12, Q13, Q20, Q21, Q28, Q29, Q36, Q37, Q44, Q45, Q52, Q53	9-04004	
16	14	RES T.O., FACT. SEL. VALUE	R23, R26, R34, R37, R45, R48, R56, R59, R67, R70, R78, R81, R89, R93		
17	16	STANDOFF TEFLON		8-91113	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.





NOTES:
1. ALL RESISTORS ARE IN OHMS, ±5%, ¼W UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS ARE IN MF
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A11
4. TP2: R94, Q56, CR1 — LAST NUMBER USED | R8-R12, R14, R15 — NUMBER NOT USED

5 FURNISHED AS PART OF 67-0513-1

6 FACTORY SELECTED VALUE

- SEE 67-5007 R1-R7 FURNISHED AS PART OF 67-0513-1

Ten Thousand Decoder.

6-97/98

AUTORANGE

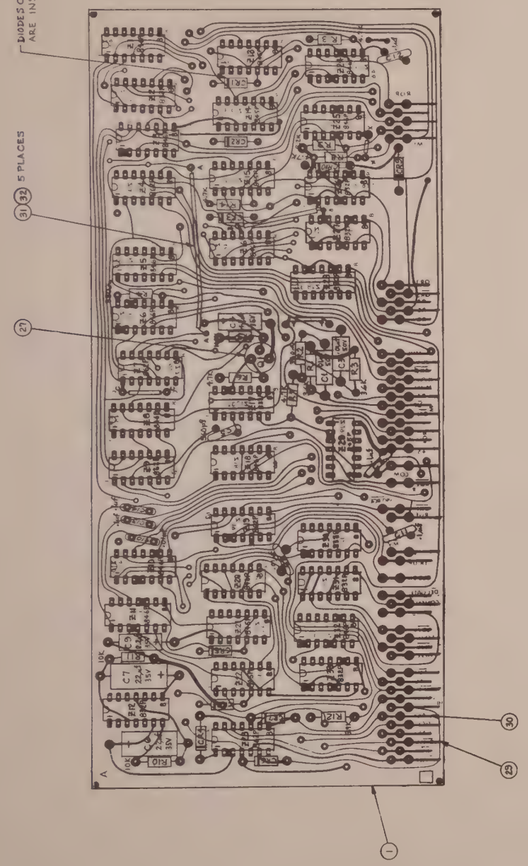
ASSEMBLY 68-6034

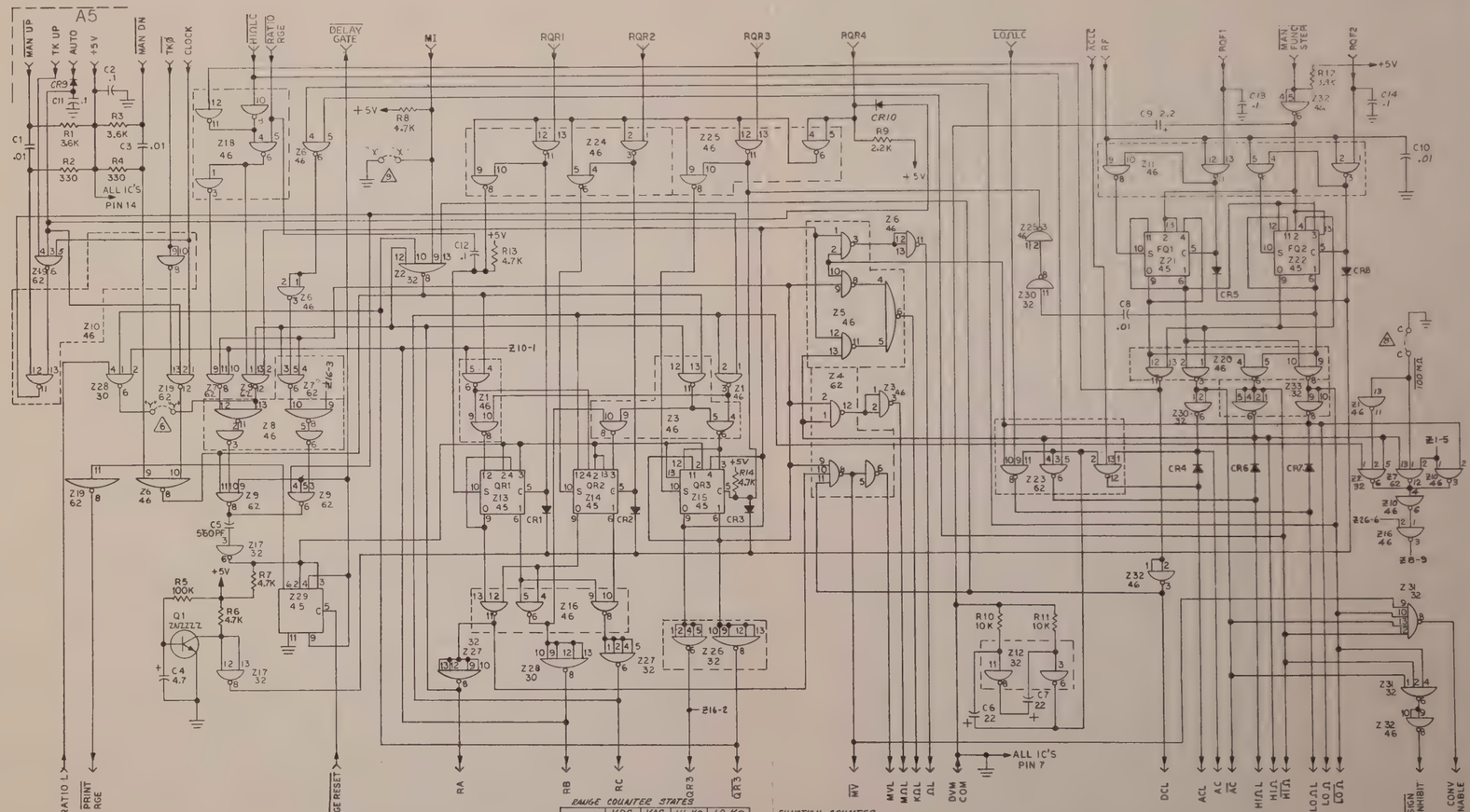
PARTS LIST

ASSEMBLY: Auto Range SCHEMATIC NO.: 68-0774 PART NO.: 68-6074

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A	CIMRON PART NO.	
1	1	ETCHED CIRCUIT BOARD		68-7074	
2	2	CAP TANT 22 ±20% 35V	C6, C7	1-57102	
3	1	CAP TANT 2.2 ±20% 35V	C9	1-57104	
4	1	CAP TANT 4.7 ±20% 35V	C4	1-57106	
5	2	CAP .01 ±10% 50V	C1, C3	1-57323	
6	1	CAP 560 pF ±10% 1000V	C5	1-57500	
7	5	CAP .1 +80% - 20% 10V	C2, C11 - C14	1-57525	
8	2	CAP .01 +80% - 20% 50V	C8, C10	1-57513	
9					
10	2	RES COMP 330	R2, R4	7-41237	
11	1	RES COMP 2.2K	R9	7-41247	
12	5	RES COMP 4.7K	R6, R7, R8, R13, R14	7-41251	
13	2	RES COMP 10K	R10, R11	7-41255	
14	1	RES COMP 100K	R5	7-41267	
15	2	RES COMP 3.6K	R1, R3	7-41300	
16	1	RES COMP 3.9K	R12	7-41250	
17					
18	10	DIODE IN914	CR1 - CR10	7-95647	
19					
20	8	INTEGRATED CIRCUIT	Z2, Z12, Z17, Z26, Z27, Z30, Z31, Z33	7-96004	
21	6	INTEGRATED CIRCUIT	Z13, Z14, Z15, Z21, Z22, Z29	7-96007	
22	13	INTEGRATED CIRCUIT	Z1, Z3, Z5, Z6, Z8, Z10, Z11, Z16, Z18, Z20, Z24, Z25, Z32	7-96008	
23	5	INTEGRATED CIRCUIT	Z4, Z7, Z9, Z19, Z23	7-96010	
24	1	INTEGRATED CIRCUIT	Z28	7-96002	
25	1	TRANSISTOR 2N2222	Q1	9-04003	
26					
27	1	INSULATOR, TRANS		5-07106	
28					
29	24	CONT ELECT LOWER		2-63904	
30	23	CONT ELECT UPPER		2-63907	
31	A/R	WIRE 24 GAUGE		9-81024	
32	A/R	TUBING - NATURAL No. 24		9-07724	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.





NOTES: UNLESS OTHERWISE SPECIFIED:

1. ALL RESISTORS ARE IN OHMS, ±5%, ¼W
2. ALL CAPACITORS ARE IN MF
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A5
4. R14, C14, Q1, CR10, Z33 | NONE
   LAST NUMBER USED | NUMBER NOT USED
5. ALL UNMARKED DIODES ARE CIMRON P/N 7-95647
6. ADD JUMPER TO INHIBIT -1 TO 1 RATIO
7. FOR ASSEMBLY DRAWING SEE 68-6074
8. INSTALL JUMPER C-C WITH 100 MEG RANGE.
9. JUMPER X-X NOT NORMALLY INSTALLED.

RANGE COUNTER STATES

	VDC	VAC	HI KΩ	LO KΩ
QR3-RA	1	1	1K	1Ω
QR3-RB	10	10	10K	10Ω
QR3-RC	100	100	100K	100Ω
QR3-RA	1K	1K	1M	1K
QR3-RB	10M		10M	10K
QR3-RC	100M		100M	

FUNCTION COUNTER STATES

	Z21-6	Z22-6
DC	0	0
AC	1	0
HIΩ	0	1
LOΩ	1	1

2. FOR SCHEMATIC SEE 68-6074.
1. PARTIAL REFERENCE DESIGNATIONS FOR COMPLETE DESIGNATOR PREFIX A5.

Autorange.

6-101/102

FUNCTION DECIMAL

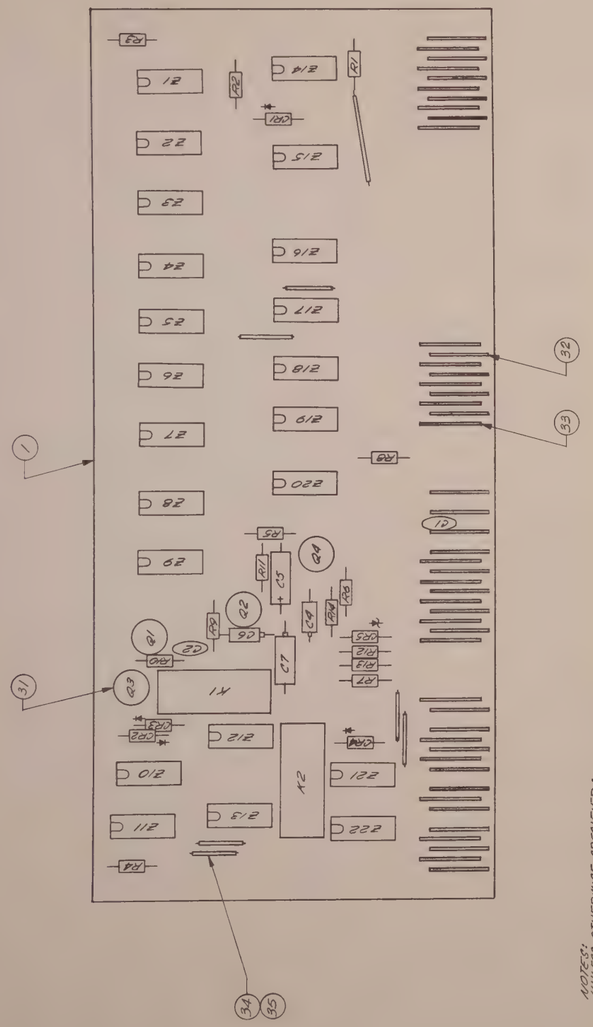
ASSEMBLY 68-6033

PARTS LIST

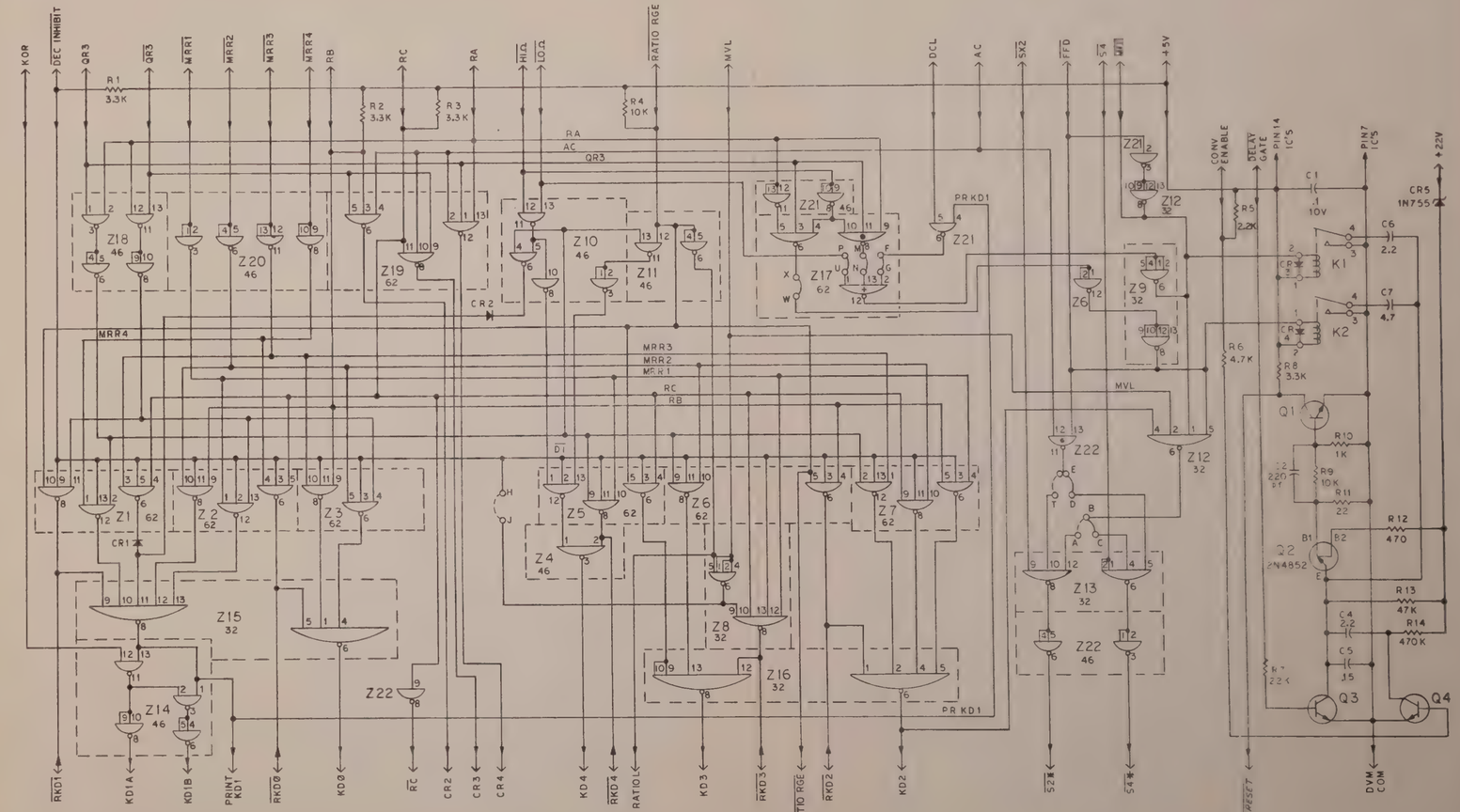
ASSEMBLY: Function Decimal SCHEMATIC NO.: 68-0733 PART NO.: 68-6033

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 4)	CIMRON PART NO.	
1	1	ETCHED CIRCUIT BOARD		68-7033	
2	1	CAP CER DISC 0.1 10V	C1	1-57525	
3	1	CAP CER DISC 220 pF	C2	1-57509	
4	2	CAP TANT 2.2 20V	C4, C6	1-57108	
5	1	CAP M PAP 0.15 50V	C5	1-57320	
6	1	CAP TANT 4.7 35V	C7	1-57106	
7					
8	4	DIODE 1N914	CR1-CR4	7-95647	
9	1	DIODE ZENER 1N755	CR5	7-95655	
10	2	RELAY REED R2191-1	K1, K2	7-38228	
11	3	TRANSISTOR NPN CIMRON SPEC 2N2222	Q1, Q3, Q4	9-04003	
12	1	TRANSISTOR 2N4852	Q2	9-04402	
13	4	RES COMP 3.3K	R1, R2, R3, R8	7-41249	
14	2	RES COMP 10K	R4, R9	7-41255	
15	1	RES COMP 2.2K	R5	7-41247	
16	1	RES COMP 4.7K	R6	7-41251	
17	1	RES COMP 22K	R7	7-41259	
18	1	RES COMP 1K	R10	7-41243	
19	1	RES COMP 22	R11	7-41223	
20	1	RES COMP 470	R12	7-41239	
21	1	RES COMP 47K	R13	7-41263	
22	1	RES COMP 470K	R14	7-41275	
23					
24					
25					
26	8	INT CIRCUIT MC 862	Z1, Z2, Z3, Z5, Z6, Z7, Z17, Z19	7-96010	
27	8	INT CIRCUIT MC 846	Z4, Z10, Z11, Z12, Z18, Z20 Z21, Z22	7-96008	
28					
29	6	INT CIRCUIT MC 832	Z8, Z9, Z12, Z13, Z15, Z16	7-96004	
30					
31	4	INSULATOR, TRANSISTOR PAD		5-07106	
32	26	CONTACT ELECT, LOWER		2-63904	
33	21	CONTACT ELECT, UPPER		2-63907	
34	A/R	WIRE, COPPER TINNED 24 GAUGE		9-81024	
35	A/R	TUBING, TEFLON NO. 24		9-07724	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



NOTES:
UNLESS OTHERWISE SPECIFIED:
1. FOR SCHEMATIC DIAGRAM SEE 68-0723
2. REFERENCE DESIGNATIONS SHOWN ARE FOR REFERENCE ONLY AND DO NOT APPEAR ON PART
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATION PREFIX WITH A#



4. C7, CR5, K2, R14, Z22 | LAST NUMBER USED | NUMBERS NOT USED
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A4
2. ALL CAPACITORS ARE IN UF
1. ALL RESISTORS ARE IN OHMS, ±5%, 1/4W.

6. ALL TRANSISTORS ARE 9-04003
5. ALL DIODES ARE CIMRON P/N 7-95647

NOTES: UNLESS OTHERWISE SPECIFIED

Function Decimal.

6-105/106

DISPLAY DRIVER

ASSEMBLY 68-6032

AND

LIGHT

SUBASSEMBLY 68-6031

PARTS LIST

ASSEMBLY: Display Driver SCHEMATIC NO.: 68-0732 PART NO.: 68-6032

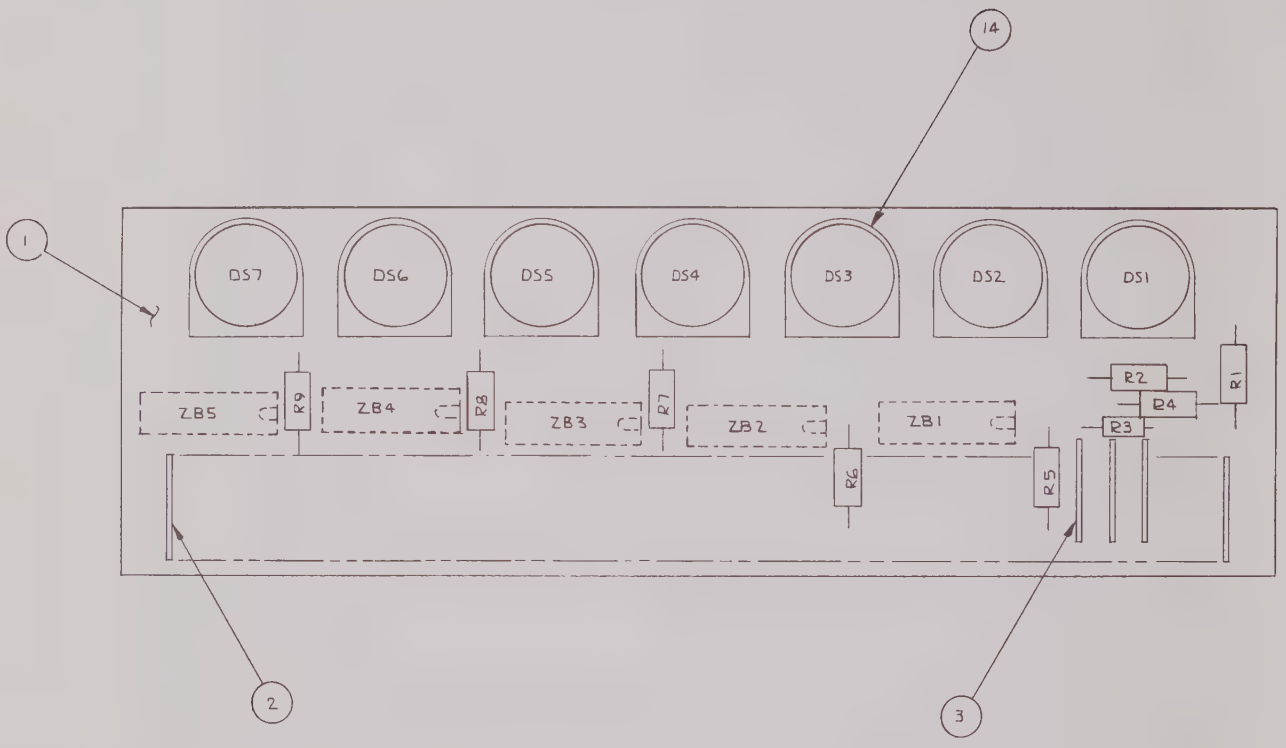
ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A3)	CIMRON PART NO.	
1	1	CIRCUIT BOARD ETCHED		68-7032	
2	1	LIGHT BOARD SUB ASSY.		68-6031	
3	33	CONTACT ELECT LOWER		2-63904	
4	34	CONTACT ELECT		2-63905	
5	24	CONTACT ELECT UPPER		2-63907	
6	4	SCREW RD HD NO. 4-40 x 1/4		7-89104-4	
7	2	WASHER FLAT NYLON		9-53043	
8	22	INSULATOR, TRANSISTOR PAD		5-07106	
9	1	CAP TANT 1 35V	C3	1-57119	
10	2	CAP ELECT 100 15V	C1, C2	1-57219	
11	1	CAP CER DISC 0.1 10V	C4	1-57525	
12					
13	10	RES COMP 27 5% 1/2W	R11-R20	7-41024	
14	2	RES COMP 330	R26, R28	7-41237	
15	3	RES COMP 1K	R10, R30, R31	7-41243	
16	2	RES COMP 2.7K	R23, R24	7-41248	
17	10	RES COMP 3.3K	R1-R9, R21	7-41249	
18	7	RES COMP 4.7K	R29, R32-R37	7-41251	
19	1	RES COMP 10K	R27	7-41255	
20	2	RES COMP 3.6K	R22, R25	7-41300	
21					
22	17	DIODE 1N914	CR1-CR14, CR16-CR18	7-95647	
23	1	DIODE ZENER 1N985	CR15	7-95674	
24					
25	1	INT CIRCUIT MC 832	Z7	7-96004	
26	2	INT CIRCUIT MC 846	Z1, Z3	7-96008	
27					
28	12	TRANSISTOR NPN CIMRON SPEC 2N2222	Q1-Q10, Q14, Q17	9-04003	
29	10	TRANSISTOR NPN CIMRON SPEC 2N3114	Q11-Q13, Q15, Q16, Q18-Q22	9-04005	
30					
31	2	BRACKET BOARD MOUNT		66-2122-1	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.

PARTS LIST

ASSEMBLY: Light Sub Assembly			SCHEMATIC NO.: 68-0732		PART NO.:68-6031
ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 3)	CIMRON PART NO.	
1	1	CIRCUIT BOARD ETCHED		68-7031	
2	31	CONTACT ELECT		2-63904	
3	3	CONTACT ELECT		2-63907	
4					
5	6	TUBE NIXIE NUMERAL	DS2-DS7	3-41408	
6	1	TUBE NIXIE POLARITY	DS1	3-41409	
7					
8	7	RESISTOR COMP 27K 1/2W	R1, R2, R5-R9	7-41060	
9	1	RESISTOR COMP 68K 1/2W	R4	7-41065	
10	1	RESISTOR COMP 100K 1/4W	R3	7-41267	
11					
12	5	INT CIRCUIT SN 7441AN	AB1-AB5	7-96032	
13					
14	7	SOCKET, NIXIE	XDS1-XDS7	8-24003	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.

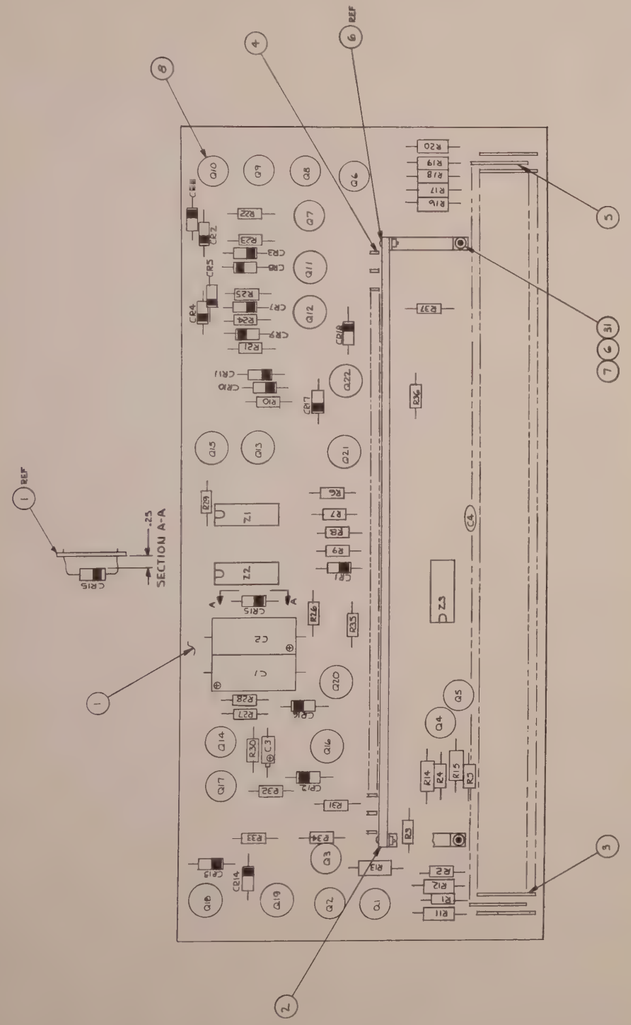


2. FOR SCHEMATIC SEE 68-0731

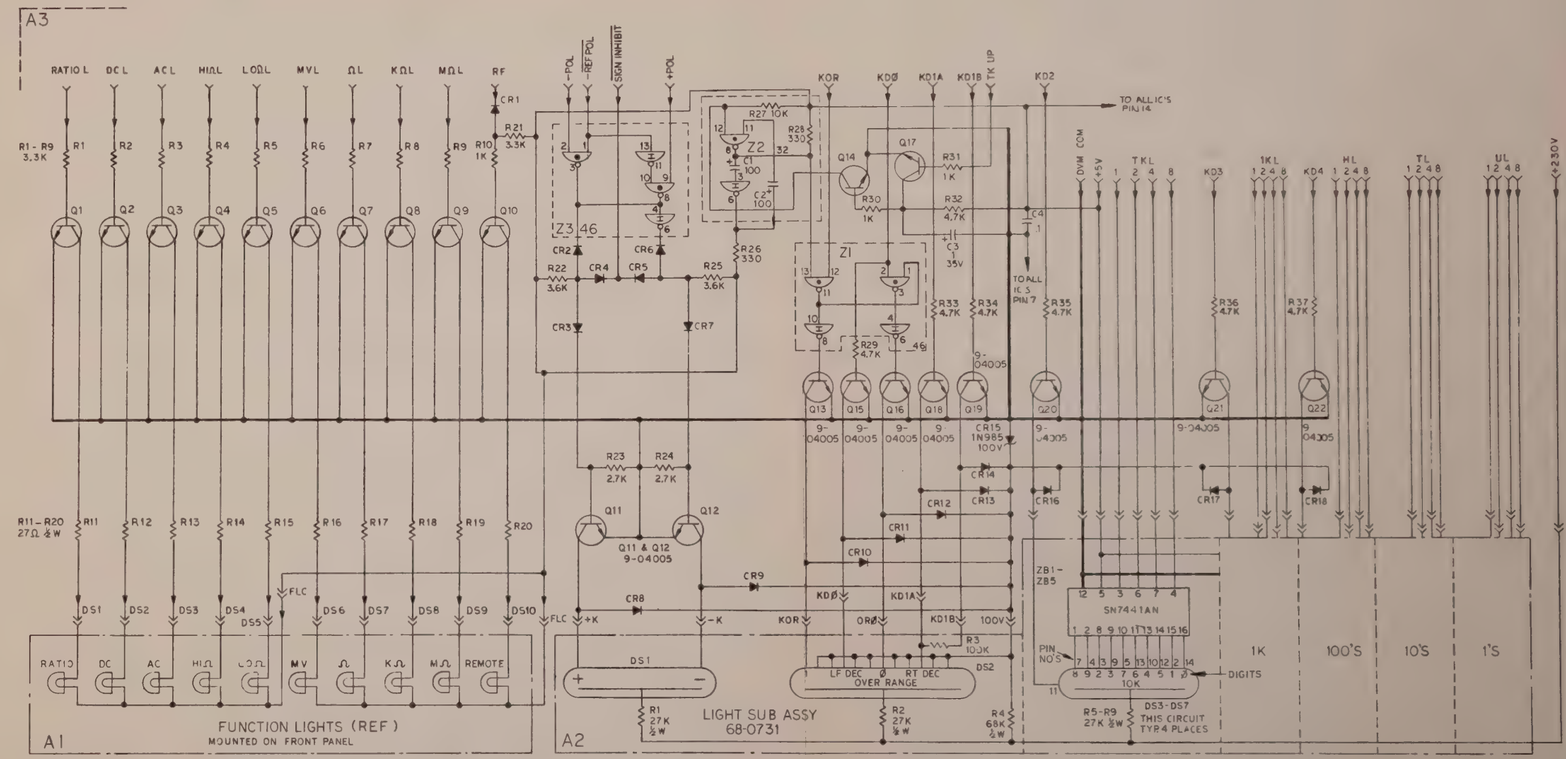
1. PARTIAL REFERENCE DESIGNATORS SHOWN FOR COMPLETE DESIGNATOR PREFIX A2

NOTES UNLESS OTHERWISE SPECIFIED

Figure 6-6. Light Subassembly



NOTES: UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ARE IN OHMS, ±5%, ¼W
2. ALL CAPACITORS ARE IN µF
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A3
4. R37, Q22, DS10, Z3 | NONE
   LAST NUMBER USED | NUMBER NOT USED
5. DIODES ARE CIMRON P/N 7-95647 CR18
6. TRANSISTORS ARE 9-04003



NOTES: UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ARE IN OHMS, ±5%, ¼W
2. ALL CAPACITORS ARE IN MF
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A2
4. R9, DS7, ZB5 | NONE
   LAST NUMBER USED | NUMBER NOT USED

THESE NOTES PERTAIN TO A2 LIGHT BOARD SUB ASSY ONLY. ASSY NO. 68-6031-1

Display Driver and Light.

6-111/112

ORIGINAL

PRINT CONTROL

ASSEMBLY 68-6041

PARTS LIST

ASSEMBLY: Print Control SCHEMATIC NO.: 68-0741 PART NO.: 68-6041

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A21)	CIMRON PART NO.	
1	1	ETCHED CIRCUIT BOARD		68-7041	
2	38	CONTACT ELECT		2-63904	
3	1	CONTACT ELECT		2-63907	
4	1	NUT HEX STAINLESS STEEL		6-36504	
5	1	SCREW 4-40 x 1/4		7-89004-4	
6	1	WASHER FLAT NO. 4		9-51504-1	
7	1	WASHER LOCK INT TOOTH		9-52504	
8					
9	2	CAP TANT 4.7 35V	C1, C23	1-57106	
10	5	CAP TANT 2.2 20V	C17, C19, C26-C28	1-57108	
11	2	CAP TANT 10 20V	C10, C11	1-57112	
12	2	CAP TANT 1 35V	C3, C22	1-57119	
13	1	CAP TANT 0.68 35V	C29	1-57120	
14	2	CAP ELEC 130 25V	C2, C5	1-57285	
15	1	CAP M PAP 0.1 50V	C21	1-57317	
16	1	CAP M PAP 0.22 50V	C9	1-57319	
17	1	CAP M PAP 1.0 50V	C14	1-57321	
18	5	CAP M PAP 0.01 50V	C4, C18, C24, C25, C31	1-57323	
19	2	CAP M PAP 0.033 50V	C16, C20	1-57330	
20	1	CAP SIL MICA 50 pF	C8	1-57487	
21	1	CAP CER DISC 0.1 10V	C15	1-57525	
22	1	CAP TANT FACT. SEL. VALUE	C30		
23	1	CAP M PAP 0.001 200V	C6	1-57371	
24	2	RES COMP 22	R17, R18	7-41223	
25	3	RES COMP 100	R3, R20, R33	7-41231	
26	1	RES COMP 270	R21	7-41236	
27	2	RES COMP 680	R44, R46	7-41241	
28	1	RES COMP 1K	R31	7-41243	
29	2	RES COMP 2.2K	R4, R35	7-41247	
30	5	RES COMP 4.7K	R27, R41-R43, R45	7-41251	
31	2	RES COMP 8.2K	R2, R6	7-41254	
32	1	RES COMP 10K	R24	7-41255	
33	6	RES COMP 22K	R8, R11, R12, R26, R32, R34	7-41259	
34	2	RES COMP 68K	R7, R29	7-41265	
35	1	RES COMP 82K	R5	7-41266	
36	2	RES COMP 100K	R15, R23	7-41267	

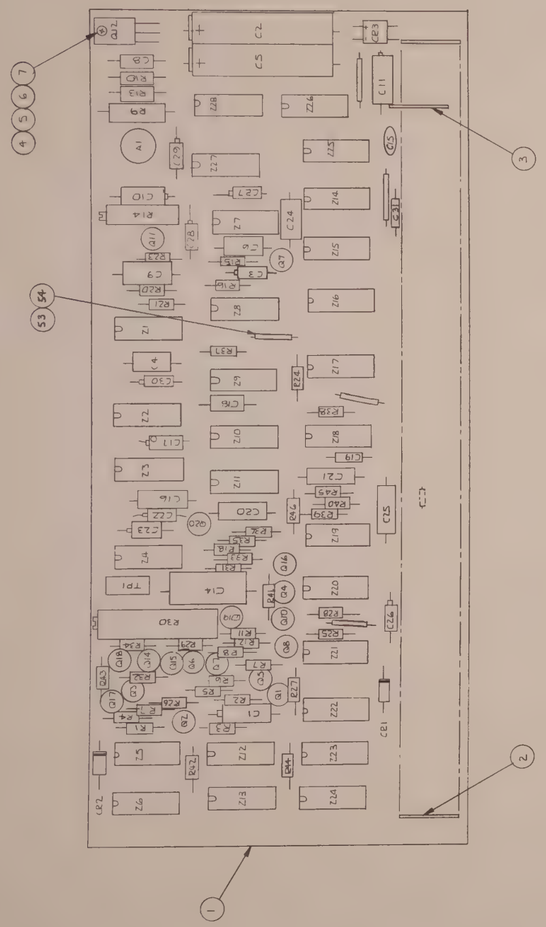
NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.

PARTS LIST

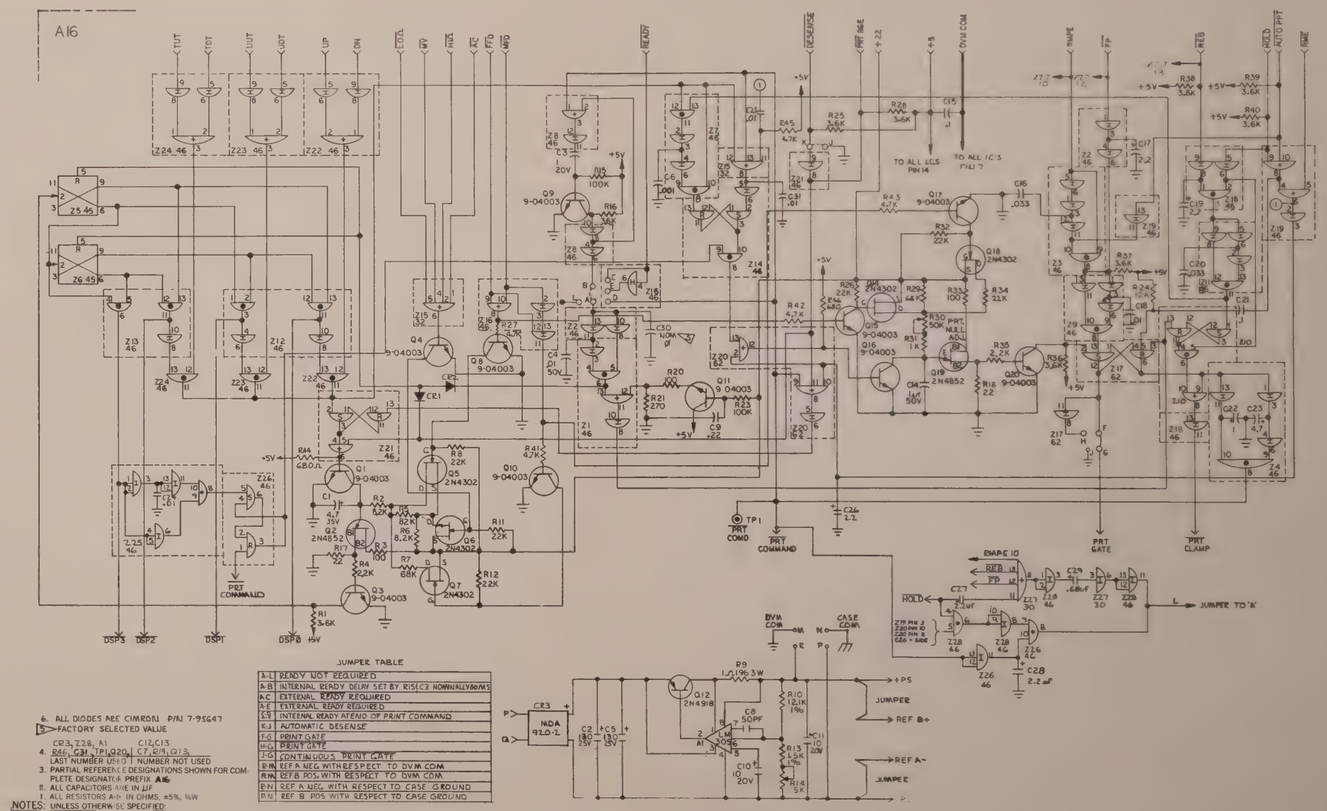
ASSEMBLY: Print Control SCHEMATIC NO.: 68-0741 PART NO.: 68-6041

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A21)	CIMRON PART NO.	
37	9	RES COMP 3.6K	R1, R16, R25, R28, R36-R40	7-41300	
38	1	RES TIN OXIDE 12.1K 1%	R10	7-46736	
39	1	RES TIN OXIDE 1.5K 1%	R13	7-46744	
40	1	RES WW 1 1% 3W	R9	7-47208	
41	1	RES VAR 50K	R30	7-54283	
42	1	RES VAR 5K	R14	7-54310	
43					
44	2	DIODE	CR1, CR2	7-95647	
45	1	DIODE	CR3	7-95660	
46					
47	1	INT CIRCUIT 930-P or equivalent	Z27	7-96002	
48	1	INT CIRCUIT 932-P or equivalent	Z15	7-96004	
49	2	INT CIRCUIT 945-P or equivalent	Z5, Z6	7-96007	
50	22	INT CIRCUIT 946-P or equivalent	Z1-Z4, Z7-Z14, Z16, Z18-Z19, Z21-Z26, Z28	7-96008	
51	2	INT CIRCUIT 962-P or equivalent	Z17, Z20	7-96010	
52					
53	A/R	TUBING TEFLON No. 24		9-07724	
54	A/R	WIRE COPPER TINNED 24 GA		9-81024	
55					
56	11	TRANSISTOR	Q1, Q3, Q4, Q8-Q11, Q15-Q17, Q20	9-04003	
57	2	TRANSISTOR 2N4852	Q2, Q19	9-04402	
58	5	TRANSISTOR 2N4302	Q5-Q7, Q14, Q18	9-04733	
59	1	TRANSISTOR 2N4918	Q12	9-04817	
60	1	AMPLIFIER LM305	A1	7-96070	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



NOTES: UNLESS OTHERWISE SPECIFIED
1. PARTIAL REFERENCE DESIGNATOR SHOWN FOR COMPLETE DESIGNATOR PREFIX A16
2. FOR SCHEMATIC SEE 68-0741


A16
JUMPER TABLE
A-L READY NOT REQUIRED
A-B INTERNAL READY DELAY SET BY R15(C3 NOMINALLY 80mS
A-C EXTERNAL READY REQUIRED
A-E EXTERNAL READY REQUIRED
C-G INTERNAL READY ATEND OF PRINT COMMAND
K-J AUTOMATIC DESENSE
F-G PRINT GATE
H-G PRINT GATE
J-G CONTINUOUS PRINT GATE
P-N REF A NEG WITH RESPECT TO DVM COM
P-N REF B POS WITH RESPECT TO DVM COM
P-N REF A NEG. WITH RESPECT TO CASE GROUND
P-N REF B POS WITH RESPECT TO CASE GROUND
NOTES: UNLESS OTHERWISE SPECIFIED
6. ALL DIODES ARE CIMRON P/N 7-95647
5 = FACTORY SELECTED VALUE
CR3, Z28, A1 C12, C13
4. R66, C24, TP1, Q20, J, C7, R19, Q13, LAST NUMBER USED / NUMBER NOT USED
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A16
2. ALL CAPACITORS ARE IN µF
1. ALL RESISTORS ARE IN OHMS, ±5%, ¼W
PRT COMMAND
PRT GATE
PRT CLAMP
JUMPER TO 'A'
TO ALL LCS PIN 14
TO ALL IC'S PIN 7

Print Control.

6-117/118

ORIGINAL

1-2-4-8 DTL PRINT OUTPUT NO. 1

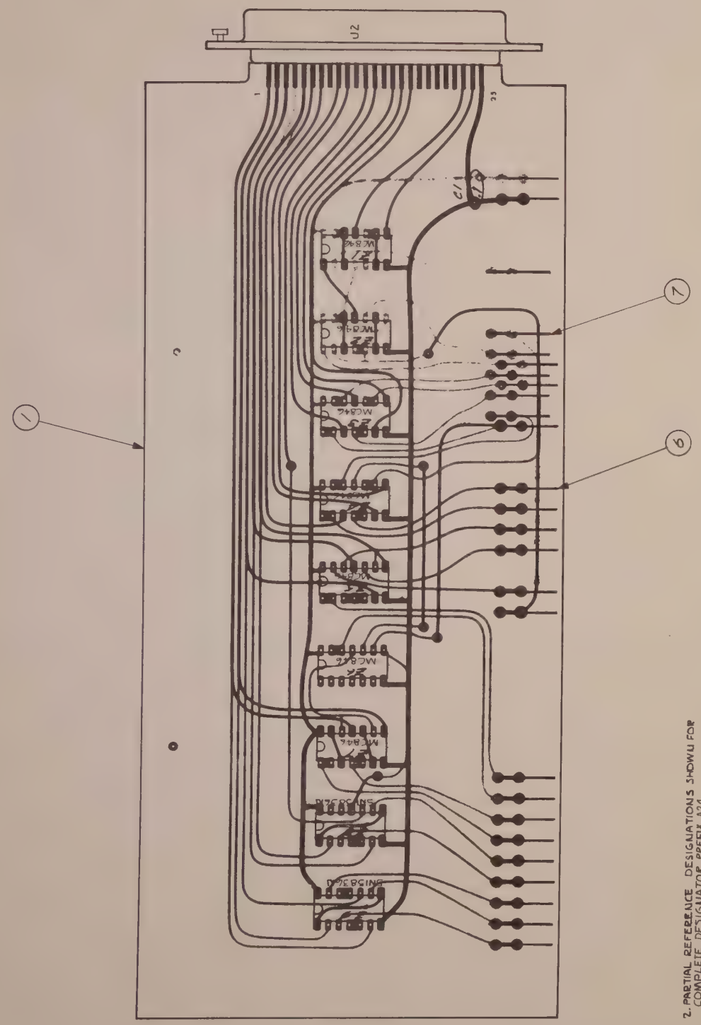
ASSEMBLY 68-6051

PARTS LIST

ASSEMBLY: 1-2-4-8 DTL Print Output No. 1 SCHEMATIC NO.: 68-0751 PART NO.: 68-6051

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 24)	CIMRON PART NO.	
1	1	ETCHED CIRCUIT BOARD		68-7051	
2	1	CAP CER DISC .1 10V	C1	1-57525	
3	7	INT CIRCUIT MC846	Z1, Z2, Z3, Z4, Z5, Z6, Z7	7-96008	
4	2	INT CIRCUIT SN15836N	Z8, Z9	7-96064	
5	1	CONNECTOR 50 PIN MODIFIED	J2	67-0518	
6	20	CONTACT ELECT, ELCO LOWER		2-63904	
7	6	CONTACT ELECT, ELCO UPPER		2-63907	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.


J2
C1
.1
10V
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
C17
C18
C19
C20
C21
C22
C23
C24
C25
C26
C27
C28
C29
C30
C31
C32
C33
C34
C35
C36
C37
C38
C39
C40

1-2-4-8 DTL PRINT OUTPUT NO. 2

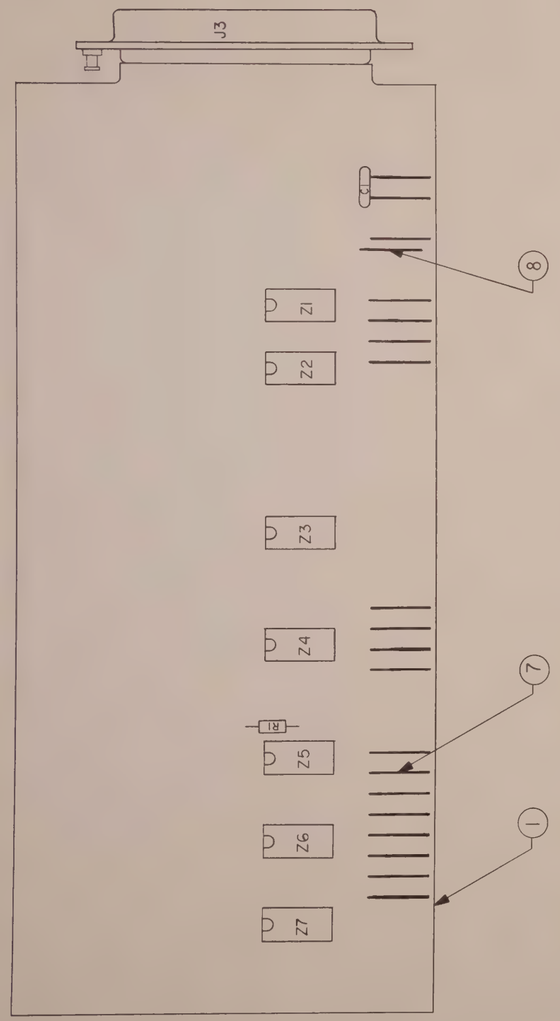
ASSEMBLY 68-6052

PARTS LIST

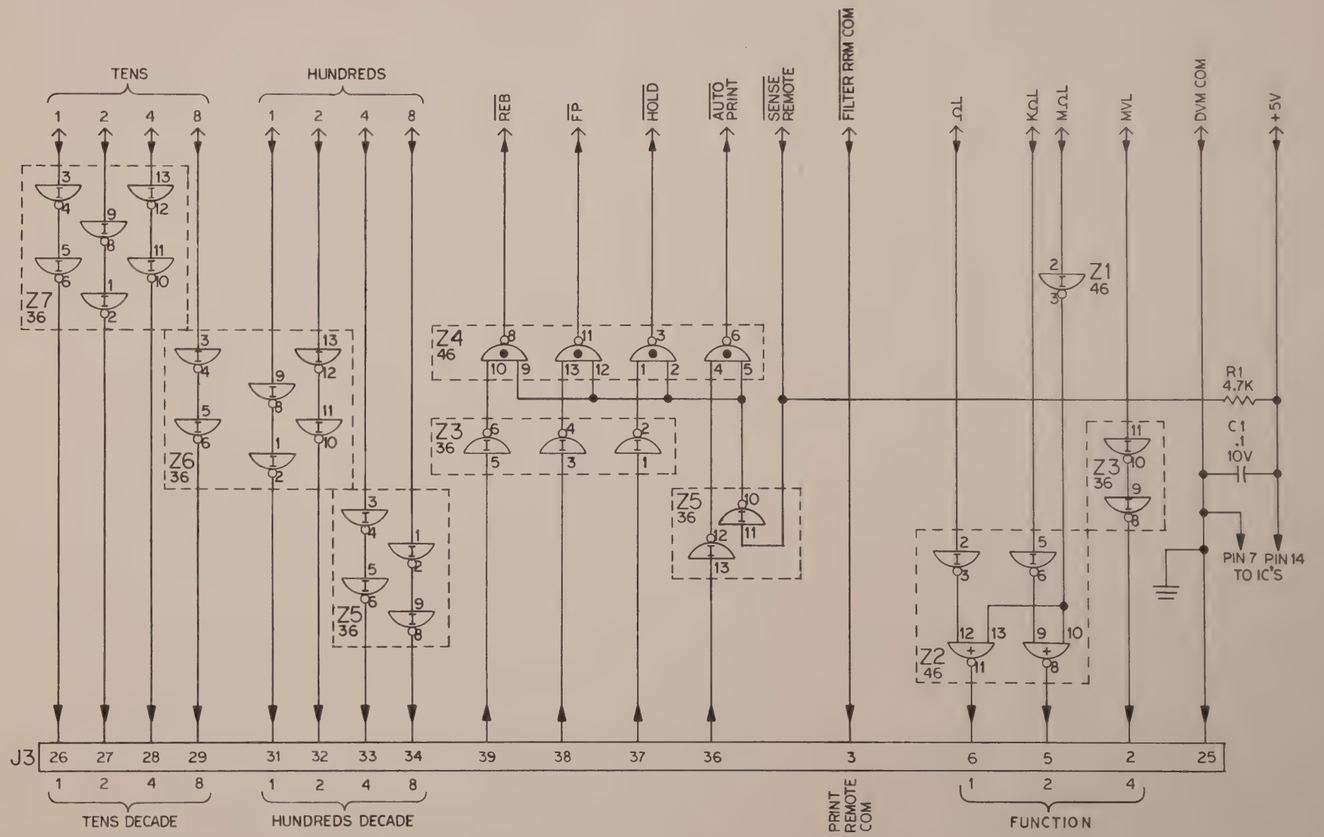
ASSEMBLY: 1-2-4-8 DTL Print Output No. 2 SCHEMATIC NO.: 68-0752 PART NO.: 68-6052

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 23)	CIMRON PART NO.	
1	1	ETCHED CKT BOARD		68-7052	
2	1	CONN 50 PIN MODIFIED	J3	67-0518-1	
3	1	CAP CER DISC .1 10V	C1	1-57525	
4	1	RES COMP 4.7K	R1	7-41251	
5	3	INT CKT MC846	Z1, Z2, Z4	7-96008	
6	4	INT CKT SN15836N	Z3, Z5, Z6, Z7	7-96064	
7	19	CONTACT ELECT, LOWER		2-63904	
8	1	CONTACT ELECT, UPPER		2-63907	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



NOTES:
1. UNLESS OTHERWISE SPECIFIED.
2. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A23
   FOR SCHEMATIC DIAGRAM SEE 68-0752



C1, R2	J1, J2
LAST NUMBER USED	NUMBER NOT USED

3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A23
2. ALL CAPACITOR ARE IN uf
1. ALL RESISTORS ARE IN OHMS, ±5%, 1/4W

NOTES: UNLESS OTHERWISE SPECIFIED

LOGIC TABLE

		8	4	2	1
FUNCTION UNITS	VOLTS	0	0	0	0
	ΩL	0	0	0	1
	KΩL	0	0	1	0
	MΩ	0	0	1	1
	MVL	0	1	0	0
TENS - NUMERALS - HUNDREDS	H0	0	0	0	0
	H1	0	0	0	1
	H2	0	0	1	0
	H3	0	0	1	1
	H4	0	1	0	0
	H5	0	1	0	1
	H6	0	1	1	0
	H7	0	1	1	1
	H8	1	0	0	0
	H9	1	0	0	1
	T0	0	0	0	0
	T1	0	0	0	1
	T2	0	0	1	0
	T3	0	0	1	1
	T4	0	1	0	0
	T5	0	1	0	1
	T6	0	1	1	0
	T7	0	1	1	1
	T8	1	0	0	0
	T9	1	0	0	1

1-2-4-8 DTL Print Output No. 2.

6-125/126

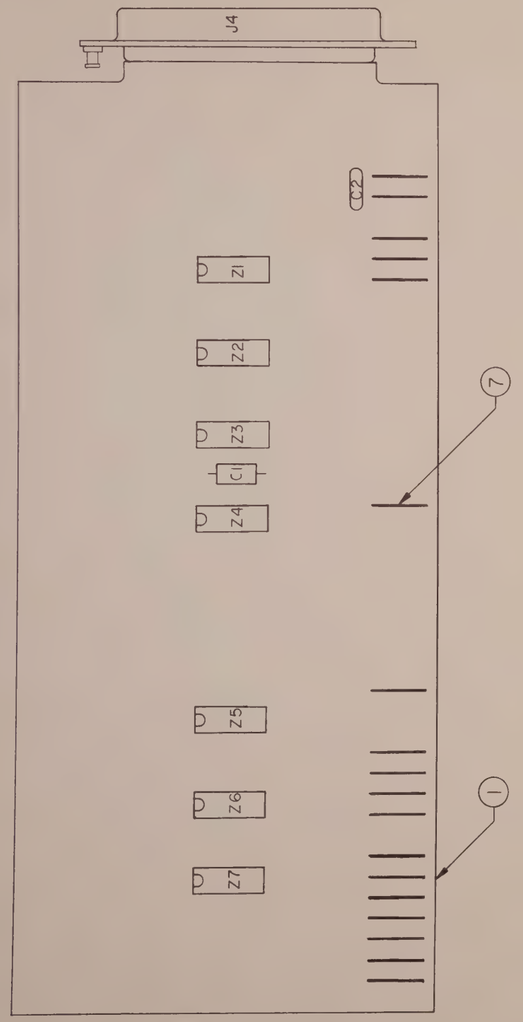
1-2-4-8 DTL PRINT OUTPUT NO. 3

ASSEMBLY 68-6053

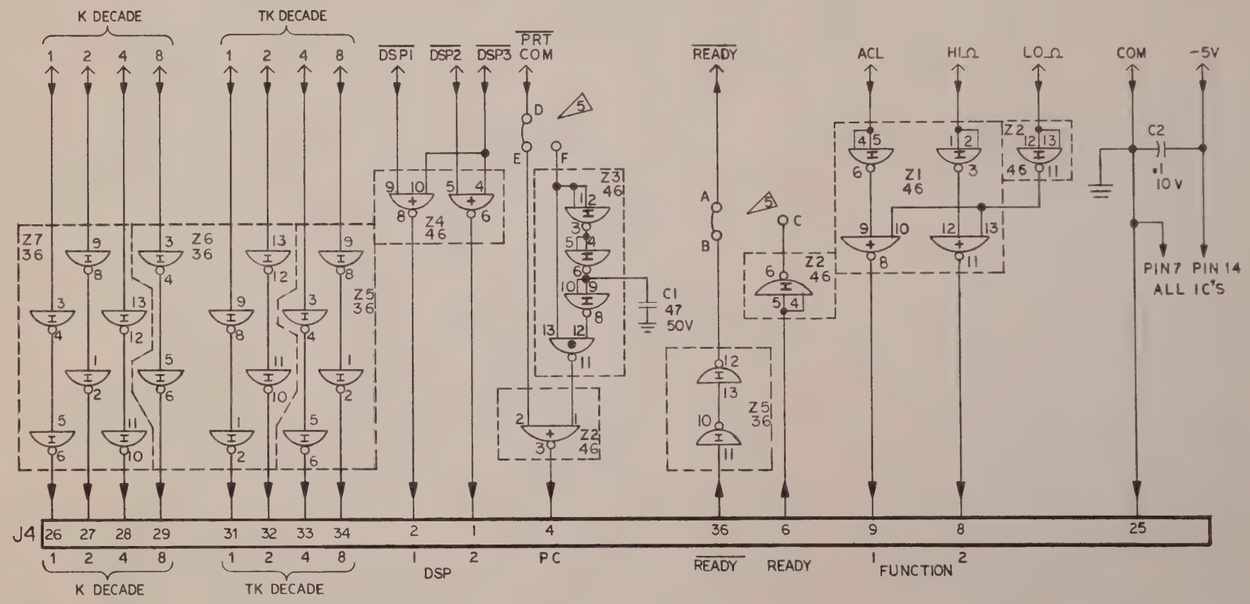
PARTS LIST

ASSEMBLY: 1-2-4-8 DTL Print Output No. 3		SCHEMATIC NO.: 68-0753		PART NO.: 68-6053	
ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 22)	CIMRON PART NO.	
1	1	ETCHED CKT BD		68-7053	
2	1	CONN 50 PIN MODIFIED	J4	67-0518-1	
3	1	CAP M PAP .47 50V	C1	1-57318	
4	1	CAP CER DISC .1 10V	C2	1-57525	
5	4	INT CKT MC846	Z1-Z4	7-96008	
6	3	INT CKT SN15836N	Z5, Z6, Z7	7-96064	
7	18	CONTACT ELEC, LOWER		2-63904	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



2. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A22
1. FOR SCHEMATIC DIAGRAM SEE 68-07753
NOTES: UNLESS OTHERWISE SPECIFIED



LOGIC TABLE

		8	4	2	1
FUNCTION	DCL	0	0	0	0
	ACL	0	0	0	1
	HIΩ	0	0	1	0
	LOΩ	0	0	1	1
DESENSE PRINT	DSP 0	0	0	0	0
	DSP 1	0	0	0	1
	DSP 2	0	0	1	0
	DSP 3	0	0	1	1
NUMERAL TK DECADE	TK 0	0	0	0	0
	TK 1	0	0	0	1
	TK 2	0	0	1	0
	TK 3	0	0	1	1
	TK 4	0	1	0	0
	TK 5	0	1	0	1
	TK 6	0	1	1	0
	TK 7	0	1	1	1
	TK 8	1	0	0	0
	TK 9	1	0	0	1
NUMERAL K DECADE	K 0	0	0	0	0
	K 1	0	0	0	1
	K 2	0	0	1	0
	K 3	0	0	1	1
	K 4	0	1	0	0
	K 5	0	1	0	1
	K 6	0	1	1	0
	K 7	0	1	1	1
	K 8	1	0	0	0
	K 9	1	0	0	1

5 SEE INSTRUCTION MANUAL CHAPTER 6

4. C2, Z7 (LAST NUMBER USED) | J1, J2, J3 (NUMBER NOT USED)
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A22
2. ALL CAPACITORS ARE IN MF
1. ALL RESISTORS ARE IN OHMS, ±5%, ¼W

NOTES: UNLESS OTHERWISE SPECIFIED:

1-2-4-8 DTL Print Output No. 3.

6-129/130

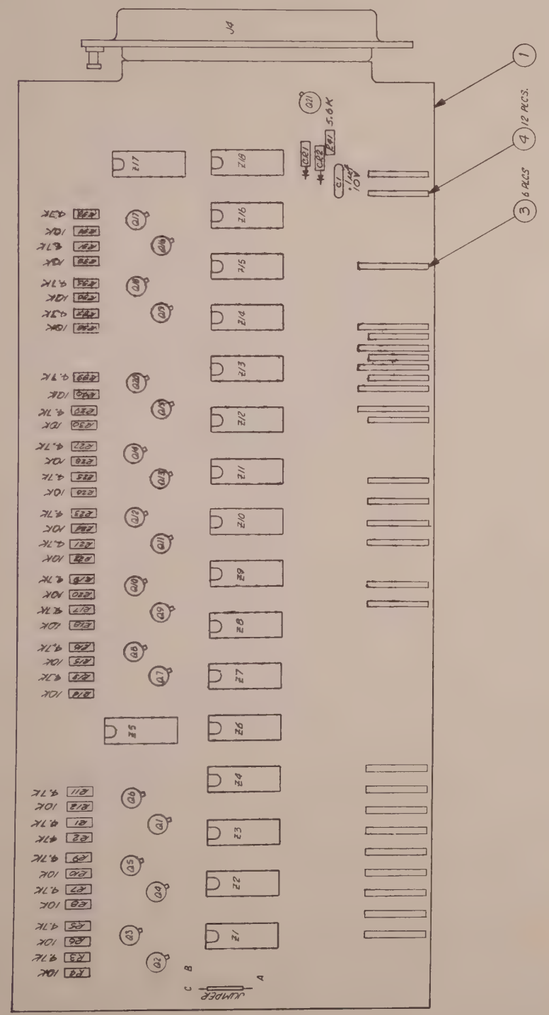
1-2-4-8 BCD VOLTAGE STATE POSITIVE
REFERENCE PRINT OUTPUT NO. 1

ASSEMBLY 68-6059

PARTS LIST

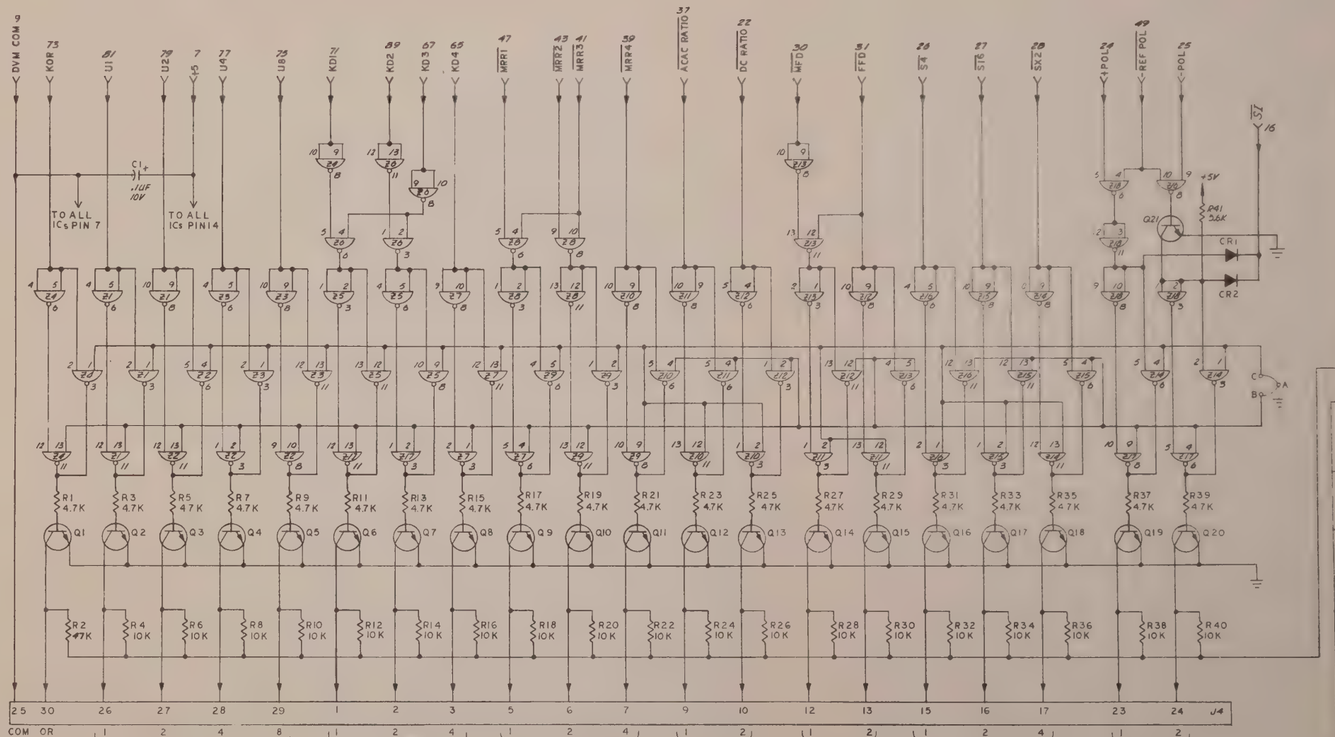
ASSEMBLY:	1-2-4-8 BCD Voltage State Positive Reference Print Output No. 1	SCHEMATIC NO.: 68-0759		PART NO.: 68-6059
ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 22)	CIMRON PART NO.
1	1	CIRCUIT BD ETCHED		68-7059
2	1	CAP CER DISC .1 10V	C1	1-57525
3	6	CONTACT ELECT		2-63907
4	12	CONTACT ELECT		2-63913
5	20	RES COMP 4.7K	R1, R3, R5, R7, R9, R11, R13, R15, R17, R19, R21, R23, R25, R27, R29, R31, R33, R35, R37, R39, R41	7-41251
6	19	RES COMP 10K	R4, R6, R8, R10, R12, R14, R16, R18, R20, R22, R24, R26, R28, R30, R32, R34, R36, R38, R40	7-41255
7	1	RES COMP 47K	R2	7-41263
8	2	DIODE	CR1, CR2	7-95647
9	18	INT. CIRCUIT 846	Z1-Z18	7-96008
10	20	TRANSISTOR 2N2222	Q1-Q20	9-04003
11	1	CONNECTOR, 50 PIN MODIFIED	J4	67-0518-1

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTORS ARE IN OHMS, 1/4W, 5%
2. ICS #1 THRU #18 ARE CIMRON P/N 7-96003
3. TRANSISTORS ARE CIMRON P/N 9-04003
4. DIODES ARE CIMRON P/N 7-95697
5. SEE DWG. 68-0759 FOR SOCKET CHART
6. REFER ALL REF DESIGN. WITH 1A22.



LOGIC TABLE

		B	A	2	1
RANGE DECIMAL	KD0	0	0	0	0
	KD1	0	0	0	1
	KD2	0	0	1	0
	KD3	0	0	1	1
	KD4	0	1	0	0
RATIO REF RANGE	MRR0	0	0	0	0
	MRR1	0	0	0	1
	MRR2	0	0	1	0
	MRR3	0	0	1	1
	MRR4	0	1	0	0
RATIO REF	INTERAL REF	0	0	0	0
	REF AC/AC RATIO	0	0	0	1
	REF DC RATIO	0	0	1	0
FILTER	FILTER MFD	0	0	0	1
	FILTER FFD	0	0	1	0
SENSITIVITY	S1	0	0	0	0
	S4	0	0	0	1
	S18	0	0	1	0
	SX2	0	1	0	0
POLARITY	S1	0	0	0	0
	- POLARITY	0	0	0	1
	+ POLARITY	0	0	1	0
NUMERAL UNITS	0	0	0	0	0
	1	0	0	0	1
	2	0	0	1	0
	3	0	0	1	1
	4	0	1	0	0
	5	0	1	0	1
	6	0	1	1	0
	7	0	1	1	1
	8	1	0	0	0
	9	1	0	0	1
KOR	OVERRANGE 0	0	0	0	0
	OVERRANGE 1	0	0	0	1

8. SEE DWG. 68-6059 FOR A994.
7. TRANSISTORS ARE CIMRON P/N 9-04003
6. NO. NOT USED = J1 THRU J3
5. LAST NO. USED: C1, CR2, J4, Q21, R41, 218.
4. PREFIX DEC DESIG. WITH 1A22
3. CR1 & 2 ARE CIMRON P/N 7-95697
2. ALL ICS ARE CIMRON P/N 7-96008
1. RESISTORS ARE IN OHMS, 1/4W, 5%.

NOTES: UNLESS OTHERWISE SPECIFIED

1-2-4-8 BCD Voltage State Positive Reference Print Output No. 1.

6-133/134

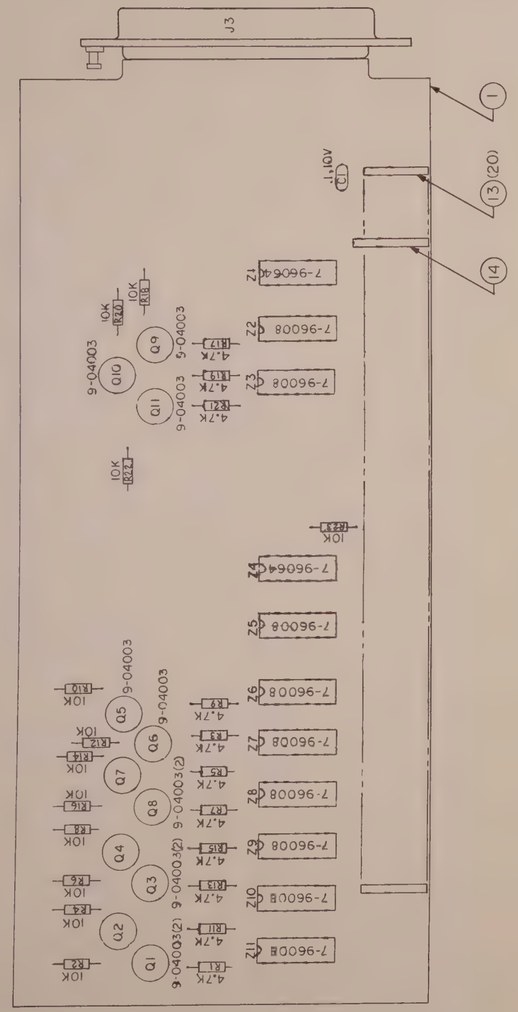
1-2-4-8 BCD VOLTAGE STATE POSITIVE
REFERENCE PRINT OUTPUT NO. 2

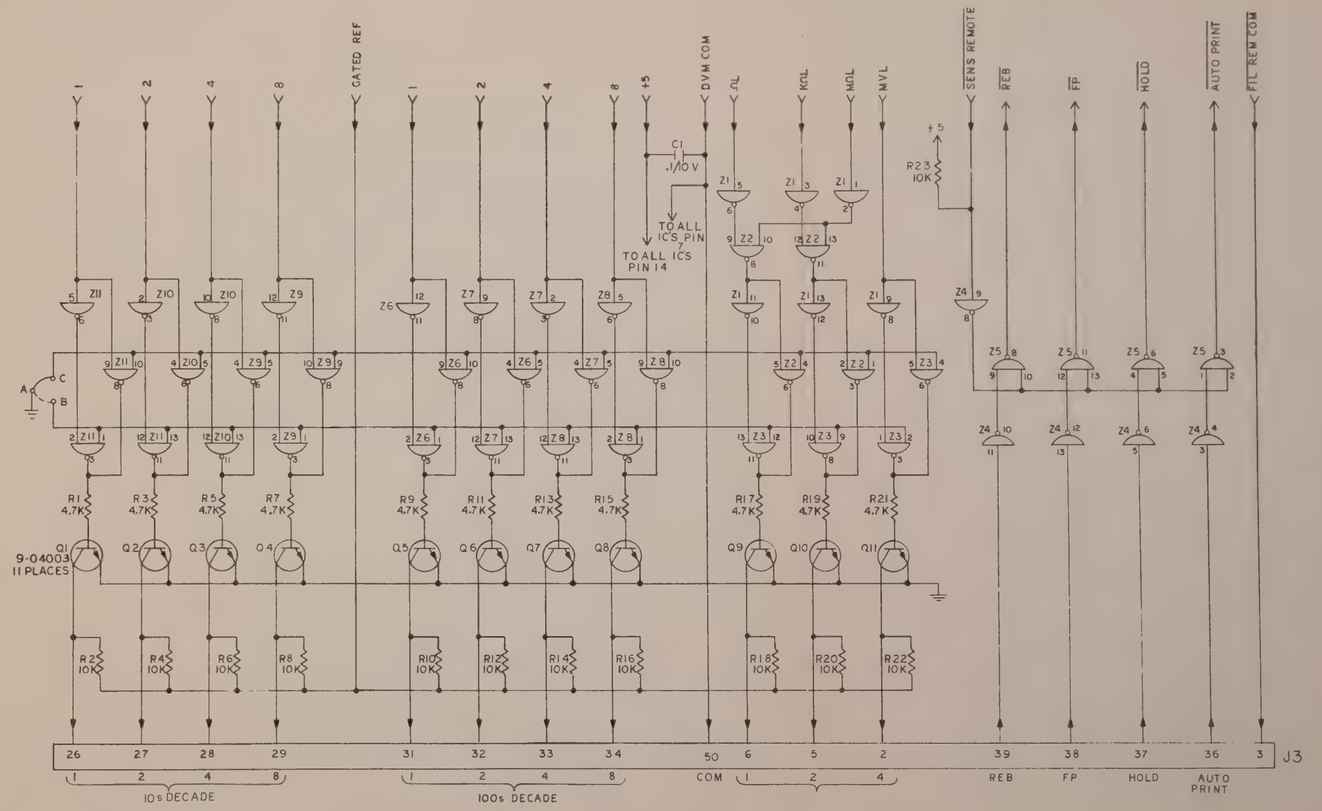
ASSEMBLY 68-6060

PARTS LIST

ASSEMBLY:	1-2-4-8 BCD Voltage State Positive Reference Print Output No. 2	SCHEMATIC NO.: 68-0760		PART NO.: 68-6060
ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 23)	CIMRON PART NO.
1	1	ETCHED CIRCUIT BOARD		68-7060
2	1	CAPACITOR .1 MFD 10V	C1	1-57525
3				
4	11	RES COMP 4.7K	R1, R3, R5, R7, R9, R11, R13, R15, R17, R19, R21	7-41251
5	12	RES COMP 10K	R2, R4, R6, R8, R10, R12, R14, R16, R18, R20, R22, R23	
6				
7	2	IC HEX INVERTER 836	Z1, Z4	7-96064
8	9	IC QUAD 2 INPUT GATE	Z2, Z3, Z5, Z6, Z7, Z8, Z9, Z10, Z11	7-96008
9				
10	11	TRANSISTOR 2N2222	Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9, Q10, Q11	9-04003
11	1	CONNECTOR 50 PIN MODIFIED	J3	67-0518-1
12				
13	20	CONTACT ELECT		2-63904
14	1	CONTACT ELECT		2-63907
15				
16	A/R	TUBING TEFLON 24 GAUGE		9-07724
17	A/R	WIRE COPPER TINNED 24 GAUGE		9-81024

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.





LOGIC TABLE

FUNCTION UNITS		8	4	2	1
	VOLTS	0	0	0	0
	ΩL	0	0	0	1
	KΩL	0	0	1	0
	MΩL	0	0	1	1
	MVL	0	1	0	0
TENS - NUMERALS - UNITS	H0	0	0	0	0
	H1	0	0	0	1
	H2	0	0	1	0
	H3	0	0	1	1
	H4	0	1	0	0
	H5	0	1	0	1
	H6	0	1	1	0
	H7	0	1	1	1
	H8	1	0	0	0
	H9	1	0	0	1
	T0	0	0	0	0
	T1	0	0	0	1
	T2	0	0	1	0
	T3	0	0	1	1
	T4	0	1	0	0
	T5	0	1	0	1
	T6	0	1	1	0
	T7	0	1	1	1
	T8	1	0	0	0
	T9	1	0	0	1

JUMPERS	
0 = +12 V 1 = 0 V	AC
0 = 0V 1 = +12 V	AB

NOTES UNLESS OTHERWISE SPECIFIED

1. ALL RESISTORS ARE IN OHMS ± 5%, 1/4W
2. ALL CAPACITORS ARE IN MFD
3. PARTIAL REFERENCE DESIGNATORS SHOWN FOR COMPLETE DESIGNATOR PREFIX 1A23

LAST NUMBER USED	NUMBER NOT USED
R23, Q11, C1, J3, Z11	NONE

1-2-4-8 BCD Voltage State Positive Reference Print Output No. 2.

6-137/138

ORIGINAL

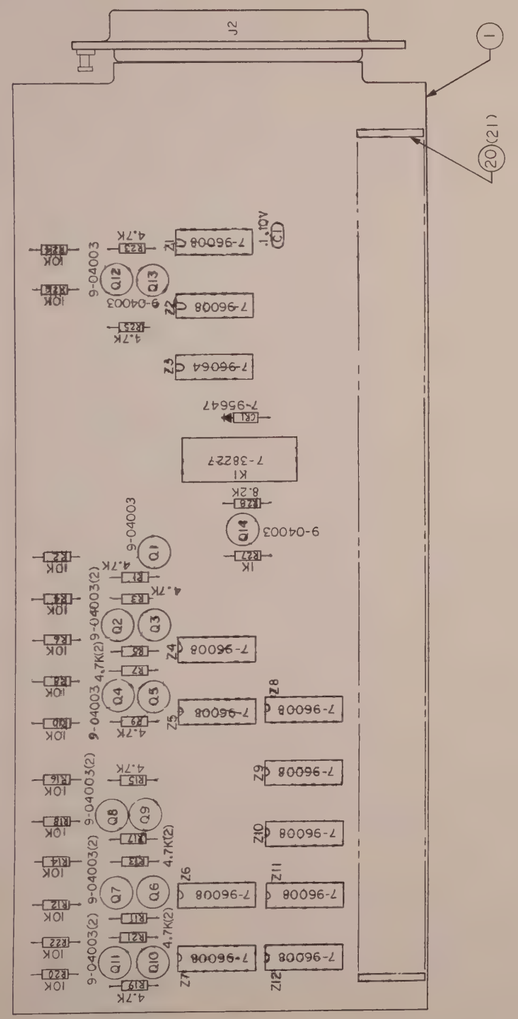
1-2-4-8 BCD VOLTAGE STATE POSITIVE
REFERENCE PRINT OUTPUT NO. 3

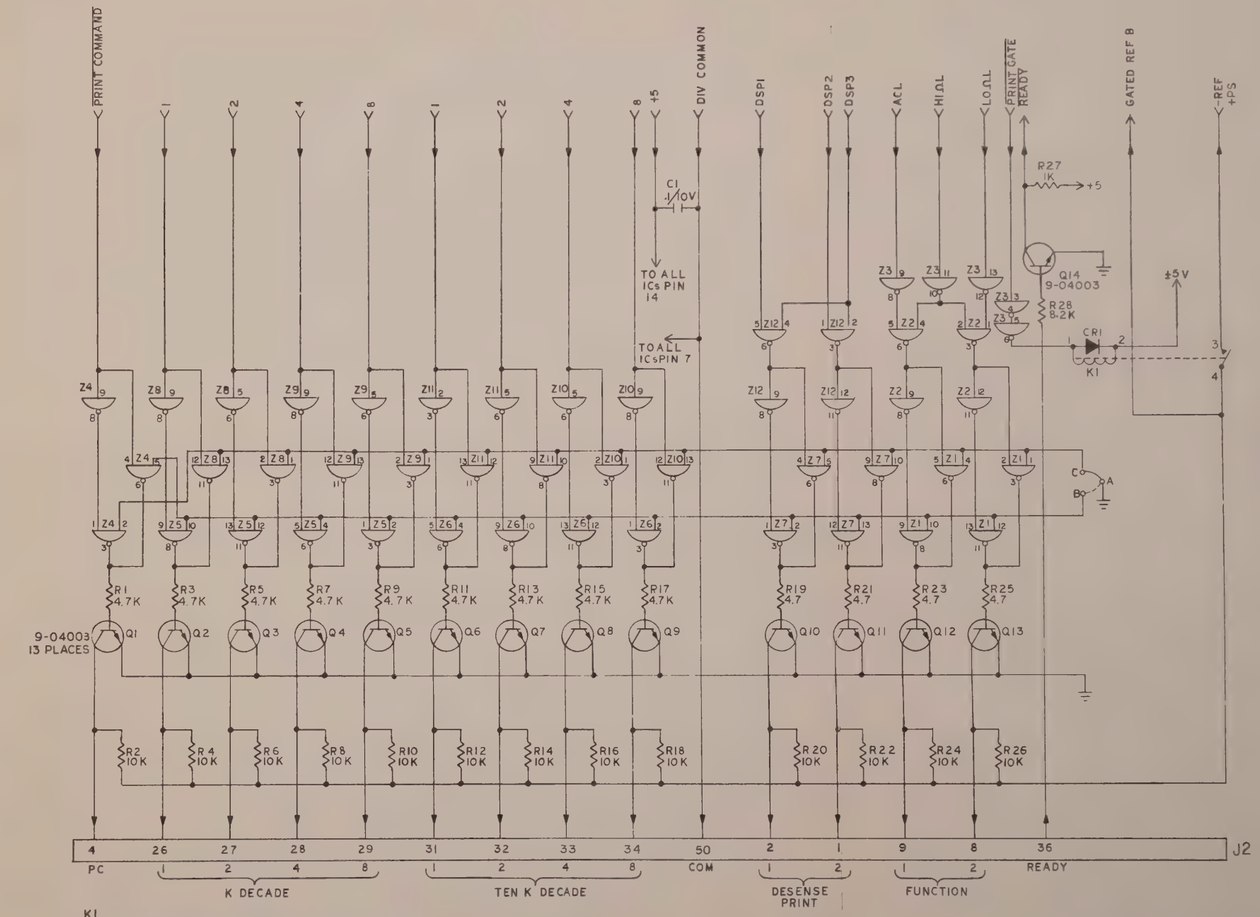
ASSEMBLY 68-6061

PARTS LIST

ASSEMBLY:	1-2-4-8 BCD Voltage State Positive Reference Print Output No. 3	SCHEMATIC NO.: 68-0761		PART NO.: 68-6061
ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 24)	CIMRON PART NO.
1	1	ETCHED CIRCUIT BOARD		68-7061
2	1	CAPACITOR .1 MFD 10V	C1	
3				
4	1	RELAY R-2191-1	K1	7-38228
5	13	RES COMP 4.7K	R1, R3, R5, R7, R9, R11, R13, R15, R17, R19, R21, R23, R25	7-41251
6	13	RES COMP 10K	R2, R4, R6, R8, R10, R12, R14, R16, R18, R20, R22, R24, R26	7-41255
7	1	RES COMP 1K	R27	7-41243
8	1	RES COMP 8.2K	R28	7-41254
9				
10	1	DIODE	CR1	7-95647
11				
12	11	IC QUAD 2 INPUT GATE	Z1, Z2, Z4-Z12	7-96008
13	1	IC HEX INVERTER 836	Z3	7-96064
14				
15	14	TRANSISTOR 2N2222	Q1-Q14	9-04003
16				
17				
18	1	CONNECTOR 50 PIN MODIFIED	J2	67-0518-1
19				
20	21	CONTACT ELECT		2-63904
21				
22	A/R	TUBING TEFLON 24 GAUGE		9-07724
23	A/R	WIRE COPPER TINNED 24 GAUGE		9-81024

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.





LOGIC TABLE

		8	4	2	1
FUNCTION	DCL	0	0	0	0
	ACL	0	0	0	1
	HIΩ	0	0	1	0
	LOΩ	0	0	1	1
PRINT	DSP0	0	0	0	0
	DSP1	0	0	0	1
	DSP1	0	0	1	0
	DSP3	0	0	1	1
NUMERAL K DECADE	TK0	0	0	0	0
	TK1	0	0	0	1
	TK2	0	0	1	0
	TK3	0	0	1	1
	TK4	0	1	0	0
	TK5	0	1	0	1
	TK6	0	1	1	0
	TK7	0	1	1	1
	TK8	1	0	0	0
	TK9	1	0	0	1
NUMERAL K DECADE	K0	0	0	0	0
	K1	0	0	0	1
	K2	0	0	1	0
	K3	0	0	1	1
	K4	0	1	0	0
	K5	0	1	0	1
	K6	0	1	1	0
	K7	0	1	1	1
	K8	1	0	0	0
	K9	1	0	0	1

K1
4. R28,Q14,C1,CR1,J2,Z12 NONE
LAST NUMBER USED/NUMBER NOT USED
3. PARTIAL REFERENCE DESIGNATORS SHOWN FOR COMPLETE DESIGNATOR PREFIX 1A24
2. ALL CAPACITORS ARE IN MFD
1. RESISTORS ARE IN OHMS ±5%, 1/4 W

NOTES: UNLESS OTHERWISE SPECIFIED

1-2-4-8 BCD Voltage State Positive Reference Print Output No. 3.

6-141/142

1-2-4-8 BCD VOLTAGE STATE NEGATIVE

REFERENCE PRINT OUTPUT NO. 1

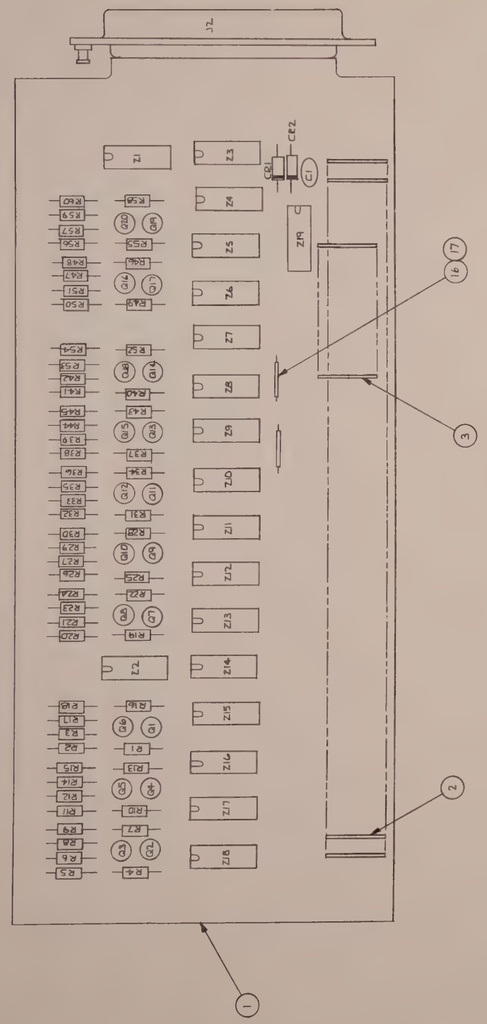
ASSEMBLY 68-6055

PARTS LIST

ASSEMBLY: 1-2-4-8 BCD Voltage State Negative Reference Print Output No. 1	SCHEMATIC NO.: 68-0755	PART NO.: 68-6055

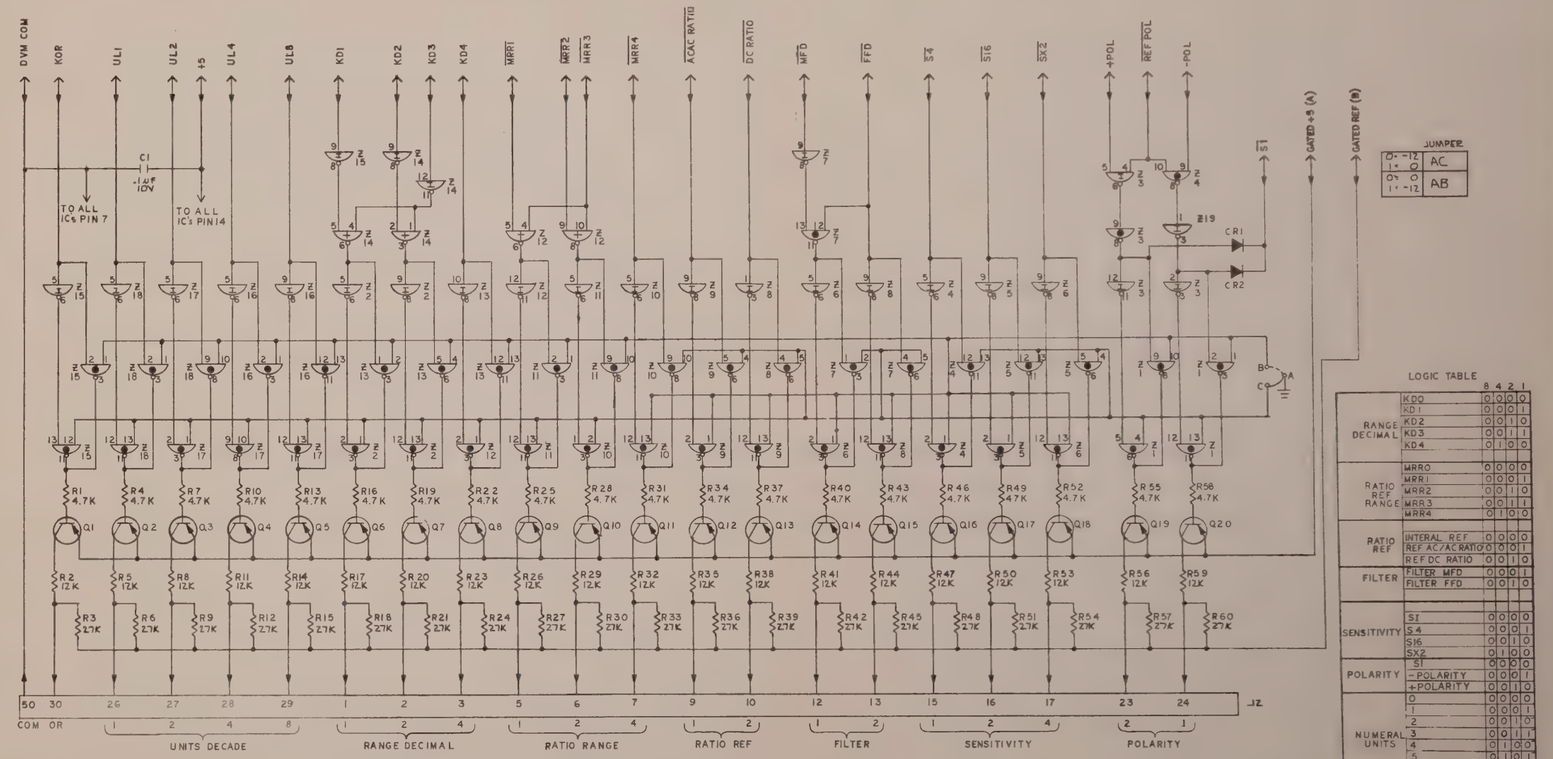
ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 24)	CIMRON PART NO.	
1	1	ETCHED CIRCUIT BOARD		68-7055	
2	22	CONTACT ELEC		2-63904	
3	6	CONTACT ELEC		2-63907	
4					
5	1	CAP DISC CER 0.1 10V	C1	1-57525	
6					
7	20	RESISTOR COMP 4.7K	R1, R4, R7, R10, R13, R16, R19, R22, R25, R28, R31, R34, R37, R40, R43, R46, R49, R52, R55, R58	7-41251	
8					
9	20	RESISTOR COMP 12K	R2, R5, R8, R11, R14, R17, R20, R23, R26, R29, R32, R35, R38, R41, R44, R47, R50, R53, R56, R59	7-41256	
10					
11	20	RESISTOR COMP 27K	R3, R6, R9, R12, R15, R18, R21, R24, R27, R30, R33, R36, R39, R42, R45, R48, R51, R54, R57, R60	7-41260	
12					
13	2	DIODE	CR1, CR2	7-95647	
14					
15	20	TRANSISTOR PNP	Q1-Q20	9-04004	
16	A/R	WIRE, BARE COPPER TINNED, 24 GAUGE		9-81024	
17	A/R	TUBING NATURAL NO. 24		9-07724	
18					
19	19	INT CIRCUIT 846	Z1-Z19	7-96008	
20					
21	1	CONN 50 PIN MODIFIED	J2	67-0518-1	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



NOTES: UNLESS OTHERWISE SPECIFIED

2. FOR SCHEMATIC SEE 68-0135
1. PARTIAL REFERENCE DESIGNATOR SHOWN FOR COMPLETE DESIGNATOR PREFIX A24



LOGIC TABLE

		8 4 2 1
RANGE DECIMAL	KD0	0 0 0 0
	KD1	0 0 0 1
	KD2	0 0 1 0
	KD3	0 0 1 1
	KD4	0 1 0 0
RATIO REF RANGE	MRR0	0 0 0 0
	MRR1	0 0 0 1
	MRR2	0 0 1 0
	MRR3	0 0 1 1
	MRR4	0 1 0 0
RATIO REF	INTERAL REF	0 0 0 0
	REF AC/AC RATIO	0 0 0 1
	REF DC RATIO	0 0 1 0
FILTER	FILTER MFD	0 0 0 1
	FILTER FFD	0 0 1 0
SENSITIVITY	SI	0 0 0 0
	S4	0 0 0 1
	S16	0 0 1 0
	SX2	0 1 0 0
POLARITY	SI	0 0 0 0
	-POLARITY	0 0 0 1
	+POLARITY	0 0 1 0
NUMERAL UNITS	0	0 0 0 0
	1	0 0 0 1
	2	0 0 1 0
	3	0 0 1 1
	4	0 1 0 0
	5	0 1 0 1
	6	0 1 1 0
	7	0 1 1 1
	8	1 0 0 0
	9	1 0 0 1
KOR	OVERRANGE 0	0 0 0 0
	OVERANGE 1	0 0 0 1

7. ALL TRANSISTORS ARE CIMRON P/N 9-04004
6. DIODES ARE CIMRON P/N 7-95647
5. PARTIAL REFERENCE DESIGNATORS SHOWN FOR COMPLETE DESIGNATORS PREFIX WITH A24
4. C1, CR2, Q20, Z19 | NONE
   LAST NO USED | NO15 NOT USED
3. ALL RESISTORS ARE IN OHMS, ¼W, 5%
2. ALL IC'S ARE 846
1. FOR ASSY DWG SEE 68-6055.

NOTES UNLESS OTHERWISE SPECIFIED

1-2-4-8 BCD Voltage State Negative Reference Print Output No. 1.

6-145/146

1-2-4-8 BCD VOLTAGE STATE NEGATIVE

REFERENCE PRINT OUTPUT NO. 2

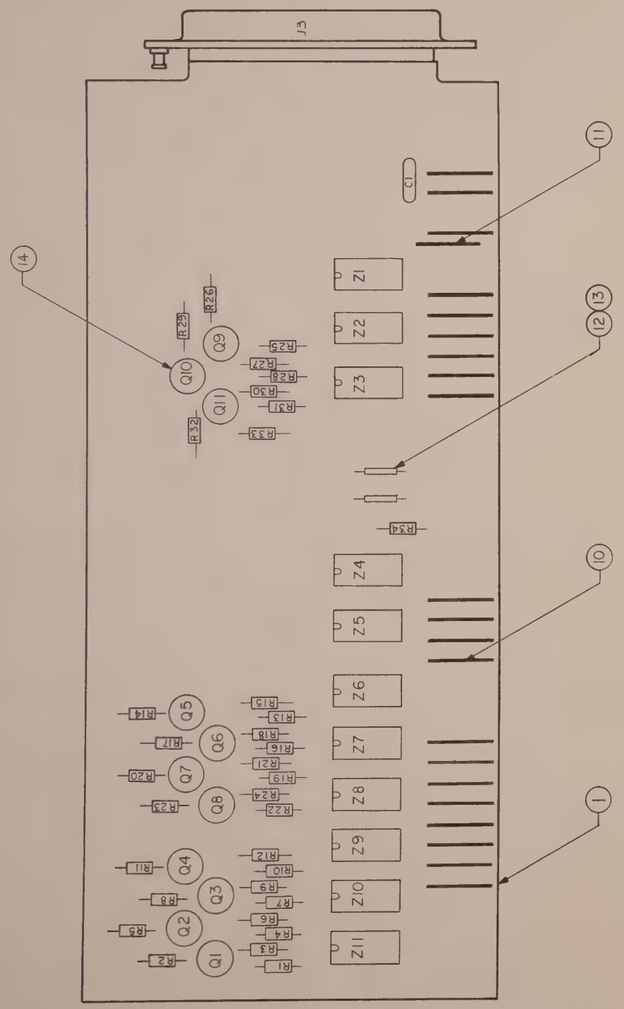
ASSEMBLY 68-6056

PARTS LIST

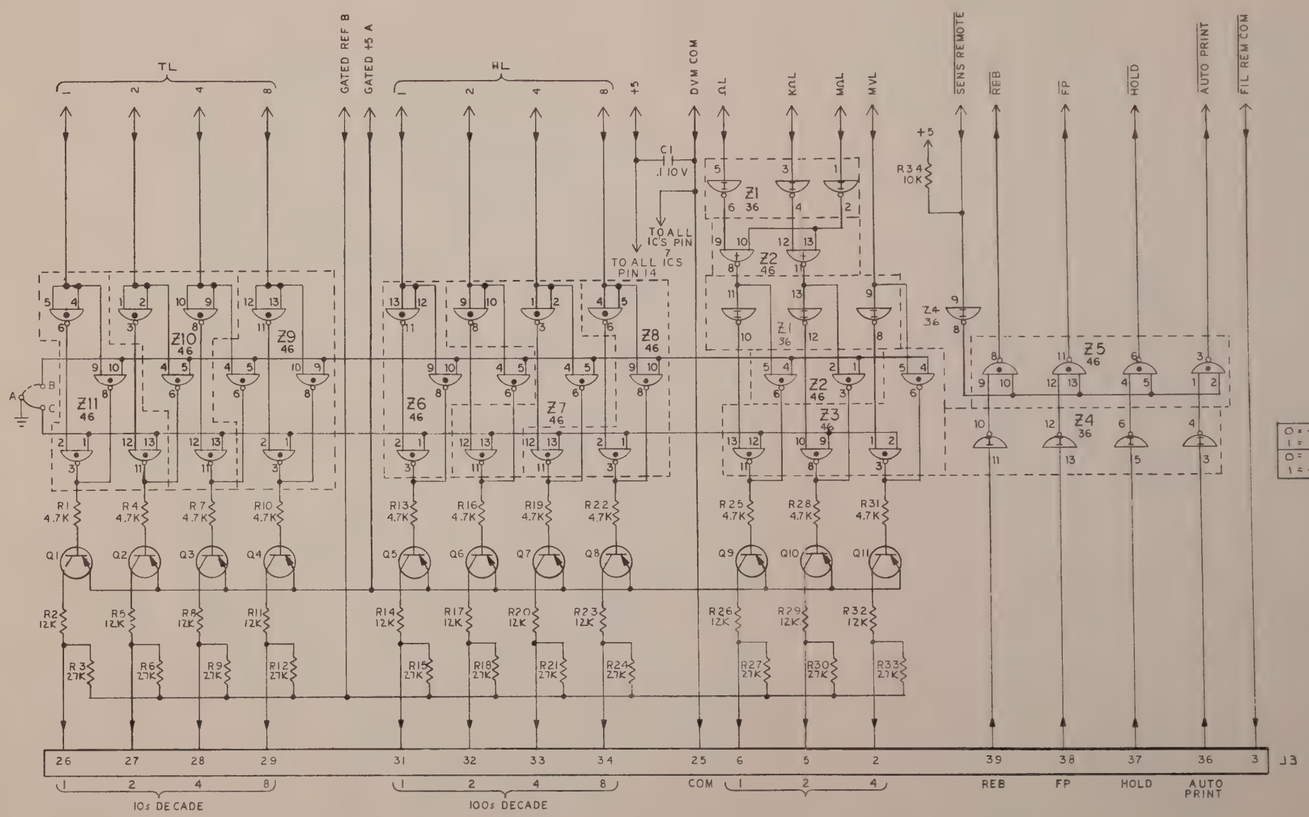
ASSEMBLY: 1-2-4-8 BCD Voltage State Negative Reference Print Output No. 2	SCHEMATIC NO.: 68-0756	PART NO.: 68-6056

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A23)	CIMRON PART NO.	
1	1	ETCHED CIRCUIT BOARD		68-7056	
2	1	CONN 50 PIN MODIFIED	J3	67-0518-1	
3	1	CAP CER DISC 0.1 10V	C1	1-57525	
4	11	RESISTOR COMP 4.7K	R1, R4, R7, R10, R13, R16, R19, R22, R25, R28, R31	7-41251	
5	11	RESISTOR COMP 12K	R2, R5, R8, R11, R14, R17, R20, R23, R26, R29, R32	7-41256	
6	11	RESISTOR COMP 27K	R3, R6, R9, R12, R15, R18, R21, R24, R27, R30, R33	7-41260	
7	9	INT CIRCUIT 846	Z2, Z3, Z5-Z11	7-96008	
8	2	INT CIRCUIT 836	Z1, Z4	7-96064	
9	11	TRANSISTOR	Q1-Q11	9-04004	
10	19	CONTACT, ELECT		2-63904	
11	1	CONTACT ELECT, UPPER		2-63907	
12	A/R	WIRE, COPPER TINNED NO. 24 GAUGE		9-81024	
13	A/R	TUBING TEFLON, 24 GAUGE		9-07724	
14	11	TRANSISTOR PAD		5-07106	
15	1	RESISTOR COMP 10K	R34	7-41255	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



NOTES: UNLESS OTHERWISE SPECIFIED
1. FOR SCHEMATIC SEE 68-0156
2. INCOMPLETE REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATION PREFIX WITH A23



NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS ±5%, 1/4 W
2. ALL CAPACITORS ARE IN μF
3. PARTIAL REFERENCE DESIGNATORS SHOWN FOR COMPLETE DESIGNATOR PREFIX A23

LAST NUMBER USED	NUMBER NOT USED
R34 Q11, C1, Z11	NONE

4. FOR ASSEMBLY SEE 68-6036
5. Q1 THRU Q11 ARE P/N 9-04004

JUMPER

0 = -12 1 = 0	AC
0 = 0 1 = -12	AB

LOGIC TABLE

FUNCTION LINES		8	4	2	1
	VOLTS	0	0	0	0
	Ω	0	0	0	1
	KΩ	0	0	1	0
	MΩ	0	0	1	1
	MV	0	1	0	0
TENS – NUMERALS – HUNDREDS	H0	0	0	0	0
	H1	0	0	0	1
	H2	0	0	1	0
	H3	0	0	1	1
	H4	0	1	0	0
	H5	0	1	0	1
	H6	0	1	1	0
	H7	0	1	1	1
	H8	1	0	0	0
	H9	1	0	0	1
	T0	0	0	0	0
	T1	0	0	0	1
	T2	0	0	1	0
	T3	0	0	1	1
	T4	0	1	0	0
	T5	0	1	0	1
	T6	0	1	1	0
	T7	0	1	1	1
	T8	1	0	0	0
	T9	1	0	0	1

1-2-4-8 BCD Voltage State Negative Reference Print Output No. 2.

1-2-4-8 BCD VOLTAGE STATE NEGATIVE

REFERENCE PRINT OUTPUT NO. 3

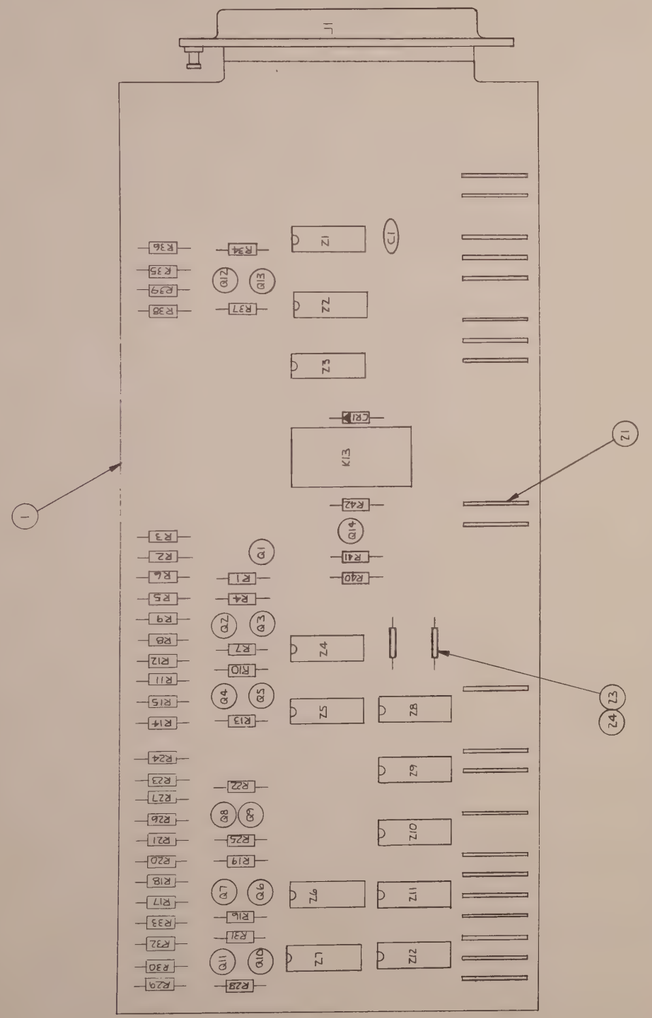
ASSEMBLY 68-6057

PARTS LIST

ASSEMBLY: 1-2-4-8 BCD Voltage State Negative Reference Print Output No. 3 SCHEMATIC NO.: 68-0757 PART NO.: 68-6057

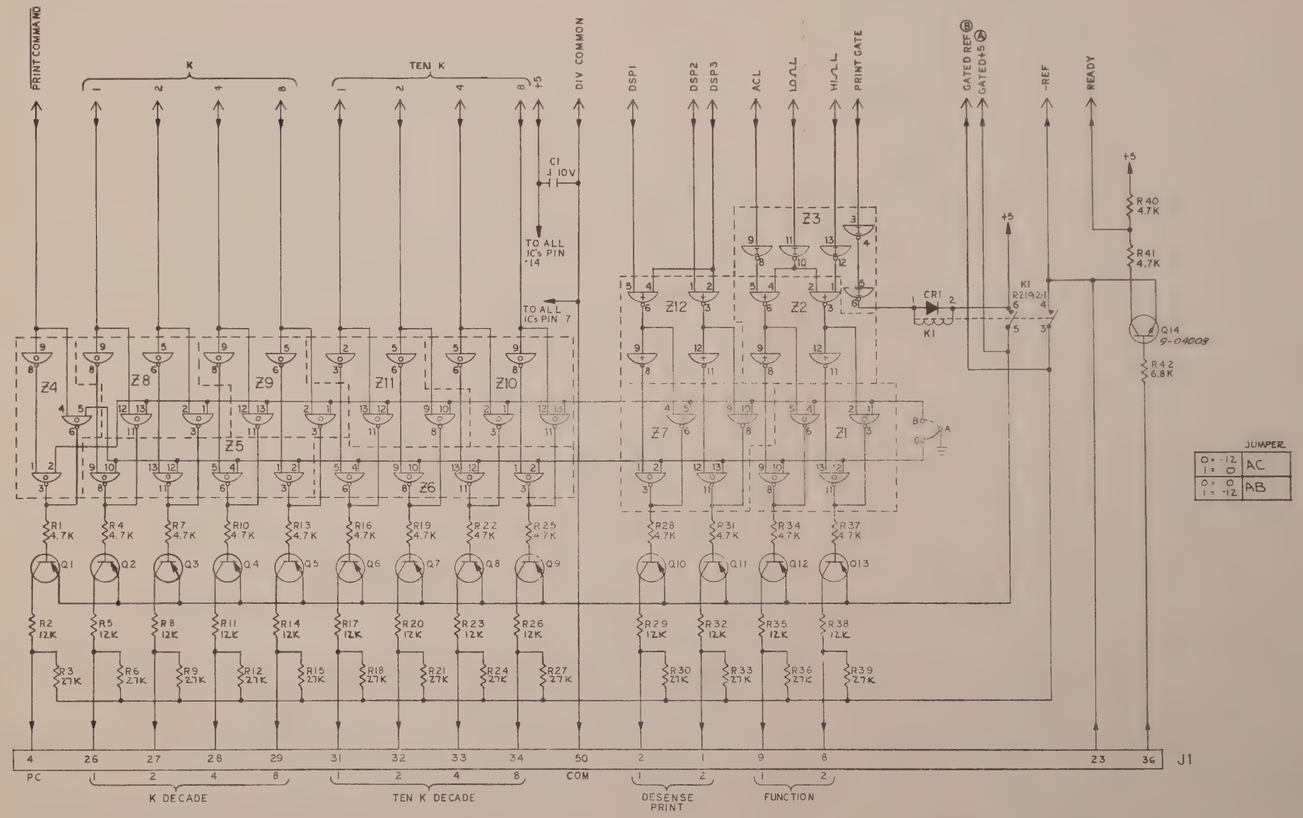
ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 22)	CIMRON PART NO.	
1	1	ETCHED CIRCUIT BOARD		68-7057	
2	1	CAPACITOR 0.1 MFD 10V	C1	1-57525	
3					
4	1	RELAY R2192-1	K13	7-38227	
5					
6	15	RES COMP 4.7K	R1, R4, R7, R10, R13, R16, R19, R22, R25, R28, R31, R34, R37, R40, R41	7-41251	
7	1	RES COMP 6.8K	R42	7-41253	
8	13	RES COMP 12K	R2, R5, R8, R11, R14, R17, R20, R23, R26, R29, R32, R35, R38	7-41256	
9	13	RES COMP 27K	R3, R6, R9, R12, R15, R18, R21, R24, R27, R30, R33, R36, R39	7-41260	
10					
11	1	DIODE	CR1	7-95647	
12					
13	1	IC HEX-INVERTER 836	Z3	7-96004	
14	11	IC QUAD 2 INPUT GATE	Z1, Z2, Z4-Z12	7-96008	
15					
16	1	TRANSISTOR NPN	Q14	9-04003	
17	13	TRANSISTOR PNP	Q1-Q13	9-04004	
18					
19	1	CONN 50 PIN MODIFIED	J1	67-0518-1	
20					
21	22	CONTACT ELECT		2-63904	
22					
23	A/R	TUBING TEFLON 24 GAUGE		9-07724	
24	A/R	WIRE COPPER TINNED NO. 24 GAUGE		9-81024	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



NOTES: UNLESS OTHERWISE SPECIFIED

1. FOR SCHEMATIC SEE 68-0757
2. INCOMPLETE REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATION PREFIX WITH A22.



NOTES: UNLESS OTHERWISE SPECIFIED

3. PARTIAL REFERANCE DESIGNATORS SHOWN FOR COMPLETE DESIGNATOR PREFIX A22.
4. ALL CAPACITORS ARE IN UF
5. ALL RESISTORS ARE IN OHMS 1/4W, 5%

R41,Q14, C1, CR1, K1	NONE
LAST NUMBER USED	NUMBER NOT USED

6. ALL DIODES ARE CIMRON P/N 7-95647
7. ALL TRANSISTORS ARE P/N 9-04004
8. FOR ASSEMBLY SEE 68-6057

LOGIC TABLE

		8	4	2	1
FUNCTION	DC	0	0	0	0
	AC	0	0	0	1
	HIAL	0	0	1	0
	LOAL	0	0	1	1
DESENSE PRINT	DSP0	0	1	0	0
	DSP1	0	1	0	1
	DSP2	0	1	1	0
	DSP3	0	1	1	1
NUMERAL TK DECADE	TK0	1	0	0	0
	TK1	1	0	0	1
	TK2	1	0	1	0
	TK3	1	0	1	1
	TK4	1	1	0	0
	TK5	1	1	0	1
	TK6	1	1	1	0
	TK7	1	1	1	1
	TK8	1	0	0	0
	TK9	1	0	0	1
NUMERAL K DECADE	K0	0	0	0	0
	K1	0	0	0	1
	K2	0	0	1	0
	K3	0	0	1	1
	K4	0	1	0	0
	K5	0	1	0	1
	K6	0	1	1	0
	K7	0	1	1	1
	K8	1	0	0	0
	K9	1	0	0	1

JUMPER

0 = -12 1 = 0	AC
0 = 0 1 = -12	AB

1-2-4-8 BCD Voltage State Negative Reference Print Output No. 3.

1-2-4-8 BCD CONTACT CLOSURE

PRINT OUTPUT NO. 1

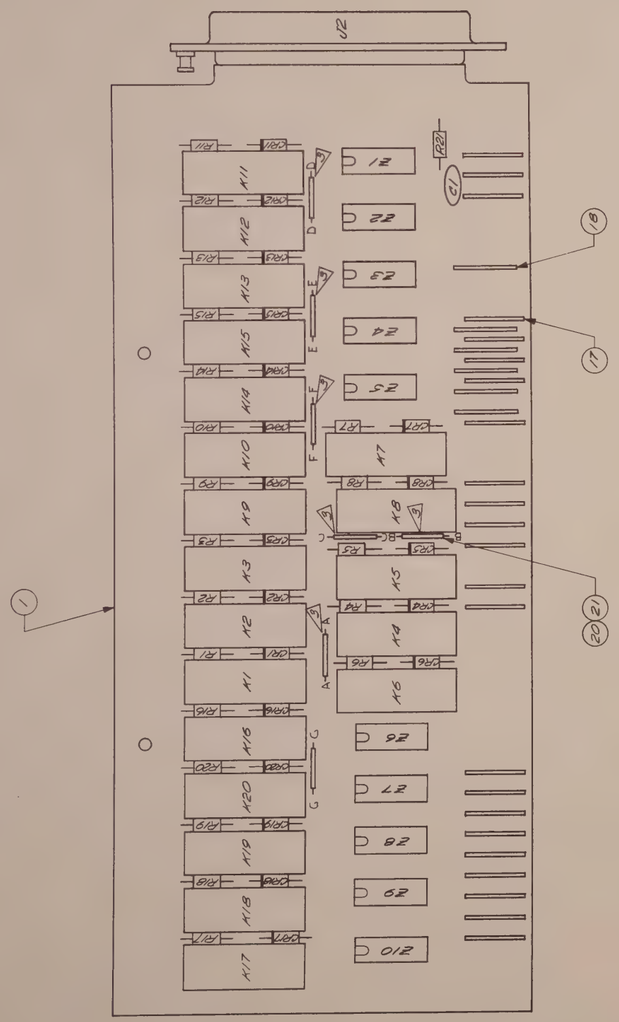
ASSEMBLY 68-6048

PARTS LIST

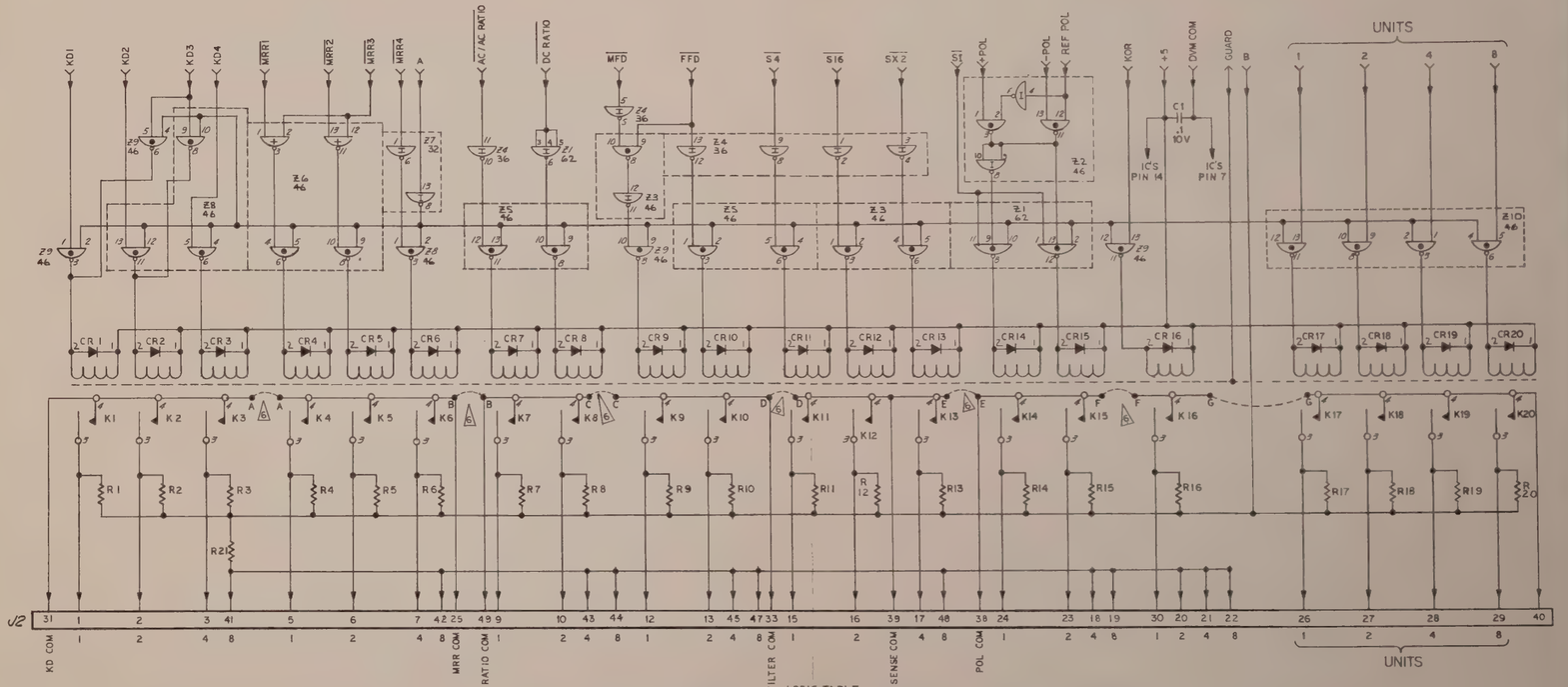
ASSEMBLY: 1-2-4-8 BCD Contact Closure Print Output No. 1 SCHEMATIC NO.: 68-0748 PART NO.: 68-6048

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 24)	CIMRON PART NO.	
1	1	ETCHED CIRCUIT BOARD		68-7048	
2					
3	1	CAP CER DISC 0.1 10V	C1	1-57525	
4					
5	20	DIODE 1N914	CR1-CR20	7-95647	
6					
7	1	50 PIN CONNECTOR, REC.	J2	67-0518	
8					
9	20	REED RELAY R2191-1	K1-K20	7-38228	
10					
11	21	RES COMP 47K	R1-R21	7-41263	
12					
13	1	INT CIRCUIT 862	Z1	7-96010	
14	7	INT CIRCUIT 846	Z2, Z3, Z5, Z6, Z8, Z9, Z10	7-96008	
15	1	INT CIRCUIT 836	Z4	7-96064	
16	1	INT CIRCUIT 832	Z7	7-96004	
17	23	CONTACT ELECT, LOWER		2-63904	
18	6	CONTACT ELECT, UPPER		2-63907	
19					
20	A/R	WIRE, NO. 24 GAUGE		9-81024	
21	A/R	TUBING, NATURAL NO. 24 GAUGE		9-07724	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



NOTES: UNLESS OTHERWISE SPECIFIED:
1. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A24
2. FOR SCHEMATIC DIAGRAM SEE 68-0748
3. SEE INSTRUCTION MANUAL CHAPTER 6



8. ALL RELAYS ARE E2191-1
7. FOR ASSEMBLY SEE 68-6048
6. ⚠ SEE INSTRUCTION MANUAL CHAPTER 6
5. ALL DIODES ARE GIMRON P/N 7-95647
4. C1, CR20, K20, R21, R22 NONE
   LAST NUMBER USED | NUMBER NOT USED
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A24
2. ALL CAPACITORS ARE IN μF
1. ALL RESISTORS ARE IN OHMS, ±5%, ¼W 47K

NOTES: UNLESS OTHERWISE SPECIFIED

LOGIC TABLE

		8 4 2 1			8 4 2 1			8 4 2 1
NUMERAL UNITS	0	0 0 0 0	RATIO REF RANGE	MRR0	0 0 0 0	RANGE DECIMAL	KD0	0 0 0 0
	1	0 0 0 1		MRR1	0 0 0 1		KD1	0 0 0 1
	2	0 0 1 0		MRR2	0 0 1 0		KD2	0 0 1 0
	3	0 0 1 1		MRR3	0 0 1 1		KD3	0 0 1 1
	4	0 1 0 0		MRR4	0 1 0 0		KD4	0 1 0 0
	5	0 1 0 1						
	6	0 1 1 0	RATIO REF	ILITERAL REF	0 0 0 0			
	7	0 1 1 1		REF AC/AC RATIO	0 0 0 1			
	8	1 0 0 0		REF DC RATIO	0 0 1 0	SENSITIVITY	S1	0 0 0 1
	9	1 0 0 1	FILTER	FILTER MFD	0 0 1 1		S4	0 0 1 0
KOR	OVERRANGE 0	0 0 0 0		FILTER FFD	0 1 0 0		SX2	0 1 0 0
	OVERRANGE 1	0 0 0 1					S1	0 0 0 1
						POLARITY	-POLARITY	0 0 0 1
							+POLARITY	0 0 1 0

1-2-4-8 BCD Contact Closure Print Output No. 1.

6-157/158

1-2-4-8 BCD CONTACT CLOSURE

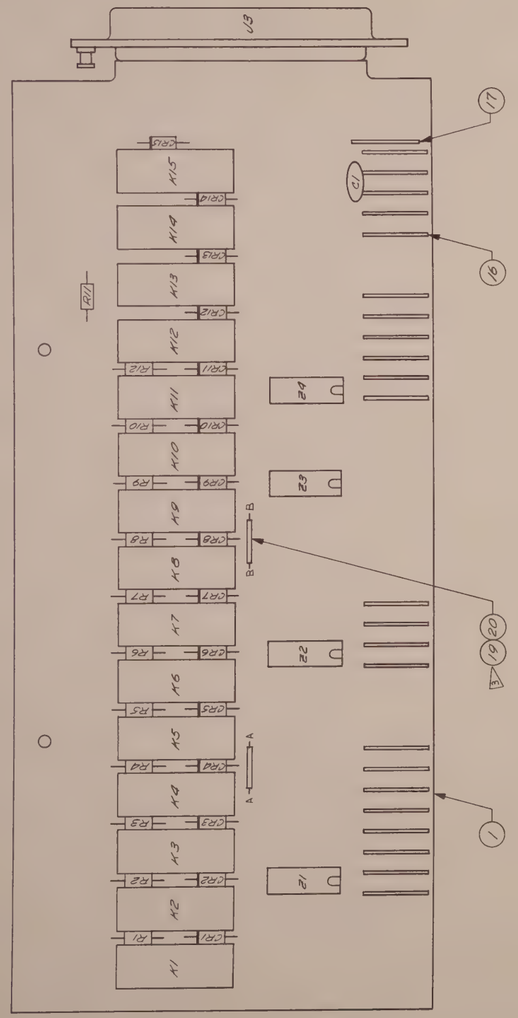
PRINT OUTPUT NO. 2

ASSEMBLY 68-6049

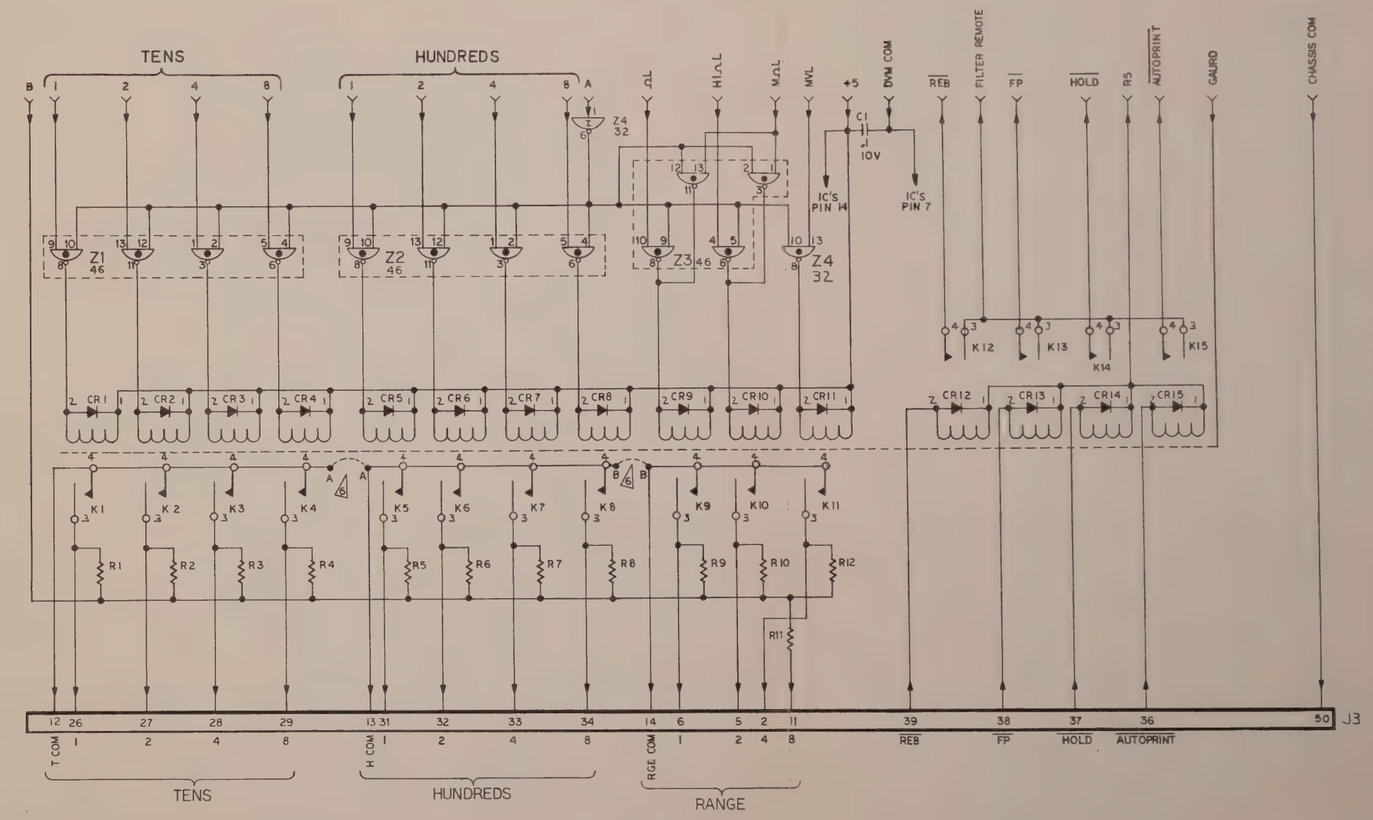
PARTS LIST

ASSEMBLY: 1-2-4-8 BCD Contact Closure Print Output No. 2		SCHEMATIC NO.: 68-0749		PART NO.: 68-6049	
ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 23)	CIMRON PART NO.	
1	1	ETCHED CIRCUIT BOARD		68-7049	
2					
3	1	CAP CER DISC 0.1 10V	C1	1-57525	
4					
5	15	DIODE	CR1-CR15	7-95647	
6					
7	1	MIN 50 PIN CON, REC	J3	67-0518	
8					
9	15	REED RELAY R2191-1	K1-K15	7-38228	
10					
11	12	RES COMP 47K	R1-R12	7-41263	
12					
13	3	INT CIRCUIT 846	Z1, Z2, Z3	7-96008	
14	1	INT CIRCUIT 832	Z4	7-96004	
15					
16	23	CONTACT ELECT, LOWER		2-63904	
17	1	CONTACT ELECT, UPPER		2-63907	
18					
19	A/R	WIRE, NO. 24 GAUGE		9-81024	
20	A/R	TUBING, NATURAL NO. 24 GAUGE		9-07724	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



NOTES: UNLESS OTHERWISE SPECIFIED:
1. PARTIAL REFERENCE DESIGNATIONS SHOWN, FOR COMPLETE DESIGNATION PREFIX A23
2. FOR SCHEMATIC DIAGRAM SEE 68-7049
3. SEE CHAPTER 5 OF INSTRUCTION MANUAL



NOTES: UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ARE IN OHMS, ±5%, ¼W 47K
2. ALL CAPACITORS ARE IN μF
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A23
4. C1, CR16, K15, R12, Z4 | NONE
   LAST NUMBER USED | NUMBER NOT USED
5. ALL DIODES ARE 7-95647
6. SEE INSTRUCTION MANUAL CHAPTER 6
7. FOR ASSEMBLY SEE 68-6049
8. ALL RELAYS ARE B2191-1

LOGIC TABLE

FUNCTION		8	4	2	1
	VOLTS	0	0	0	0
	Ω	0	0	0	1
	KΩ	0	0	1	0
	MΩ	0	0	1	1
	MV	0	1	0	0
TENS - NUMERALS - HUNDREDS	H0	0	0	0	0
	H1	0	0	0	1
	H2	0	0	1	0
	H3	0	0	1	1
	H4	0	1	0	0
	H5	0	1	0	1
	H6	0	1	1	0
	H7	0	1	1	1
	H8	1	0	0	0
	H9	1	0	0	1
	T0	0	0	0	0
	T1	0	0	0	1
	T2	0	0	1	0
	T3	0	0	1	1
	T4	0	1	0	0
	T5	0	1	0	1
	T6	0	1	1	0
	T7	0	1	1	1
	T8	1	0	0	0
	T9	1	0	0	1

1-2-4-8 BCD Contact Closure Print Output No. 2.

6-161/162

1-2-4-8 BCD CONTACT CLOSURE

PRINT OUTPUT NO. 3

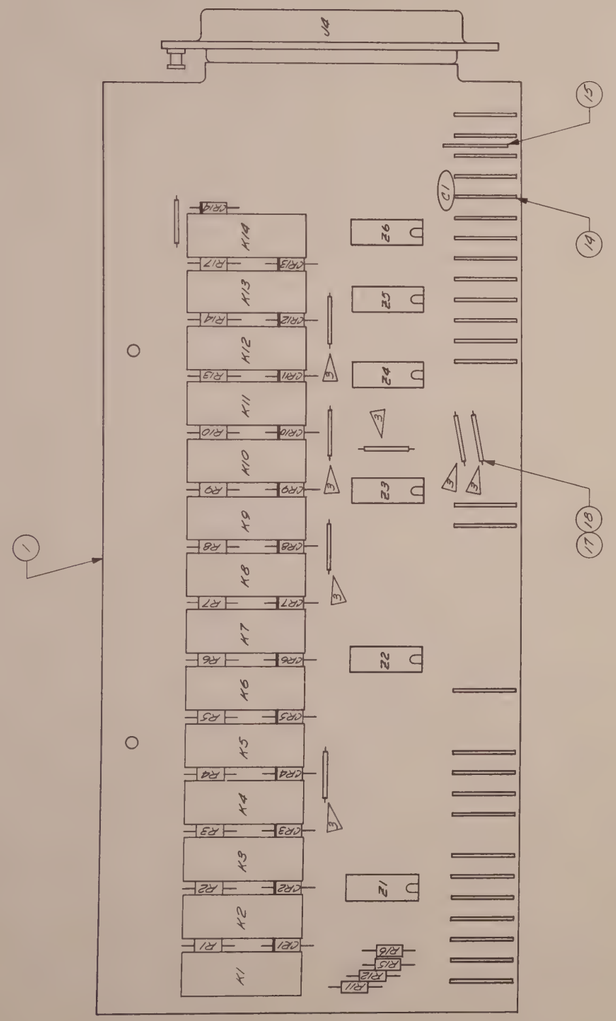
ASSEMBLY 68-6050

PARTS LIST

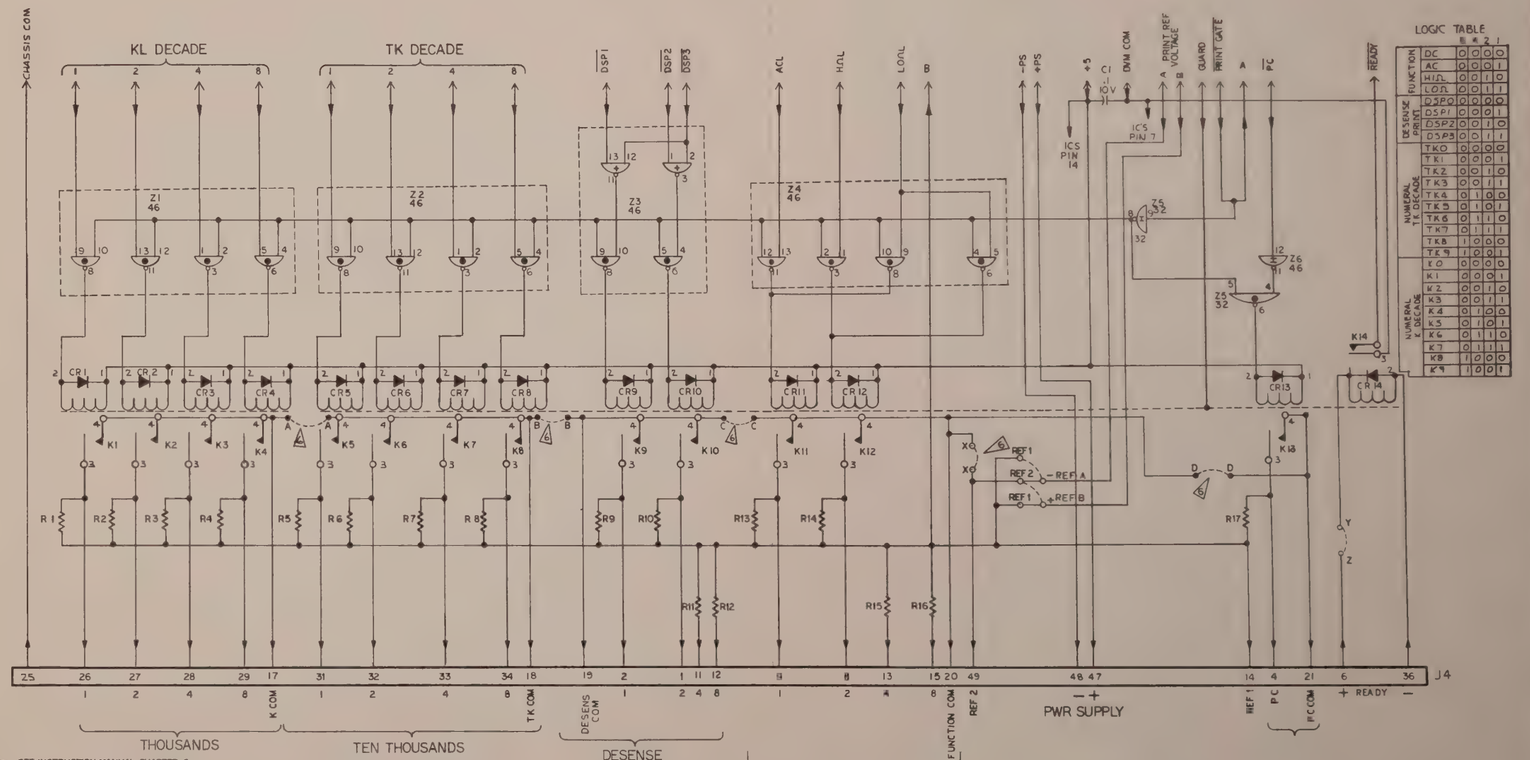
ASSEMBLY:	1-2-4-8 BCD Contact Closure Print Output No. 3	SCHEMATIC NO.: 68-0750	PART NO.: 68-6050

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A22)	CIMRON PART NO.
1	1	ETCHED CIRCUIT BOARD		68-7050
2				
3	1	CAP CER DISC 0.1 10V	C1	1-57525
4				
5	14	DIODE	CR1-CR14	7-95647
6				
7	1	MIN 50 PIN CON, REC	J4	67-0518
8	15	REED RELAY R2191-1	K1-K15	7-38228
9	17	RES COMP 47K	R1-R17	7-41263
10				
11	5	INT CIRCUIT 846	Z1, Z2, Z3, Z4, Z6	7-96008
12	1	INT CIRCUIT 832	Z5	7-96004
13				
14	27	CONTACT ELECT, LOWER		2-63904
15	1	CONTACT ELECT, UPPER		2-63907
16				
17	A/R	WIRE, NO. 24 GAUGE		9-81024
18	A/R	TUBING, NATURAL, NO. 24 GAUGE		9-07724

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



NOTES: UNLESS OTHERWISE SPECIFIED:
1. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATION PREFIX WITH A22
2. FOR SCHEMATIC DIAGRAM SEE 68-0130
3. SEE CHAPTER 6 OF INSTRUCTION MANUAL



LOGIC TABLE

	FUNCTION	E	8	4	2	1
	DC	0	0	0	0	0
	AC	0	0	0	0	1
	H/L	0	0	0	1	0
	LO/L	0	0	0	1	1
DESENSE PRINT	DSP0	0	0	1	0	0
	DSP1	0	0	1	0	1
	DSP2	0	0	1	1	0
	DSP3	0	0	1	1	1
NUMERAL TK DECADE	TK0	0	1	0	0	0
	TK1	0	1	0	0	1
	TK2	0	1	0	1	0
	TK3	0	1	0	1	1
	TK4	0	1	1	0	0
	TK5	0	1	1	0	1
	TK6	0	1	1	1	0
	TK7	0	1	1	1	1
	TK8	1	0	0	0	0
	TK9	1	0	0	0	1
NUMERAL K DECADE	K0	0	0	0	0	0
	K1	0	0	0	0	1
	K2	0	0	0	1	0
	K3	0	0	0	1	1
	K4	0	1	0	0	0
	K5	0	1	0	0	1
	K6	0	1	1	1	0
	K7	0	1	1	1	1
	K8	1	0	0	0	0
	K9	1	0	0	0	1

6 SEE INSTRUCTION MANUAL CHAPTER 6

5 ALL DIODES ARE CIMRON P/N 7-95647

4. R 17 , CR 14 | NONE
LAST NUMBER USED | NUMBER NOT USED

3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A22

2. ALL CAPACITORS ARE IN MF

1. ALL RESISTORS ARE IN OHMS, ±5%, ¼W 47K

NOTES: UNLESS OTHERWISE SPECIFIED:

8. ALL RELAYS ARE R2191

7. FOR ASSEMBLY DWG SEE 68-6050

1-2-4-8 BCD Contact Closure Print Output No. 3.

6-165/166

TEN-LINE PRINT OUTPUT NO. 1

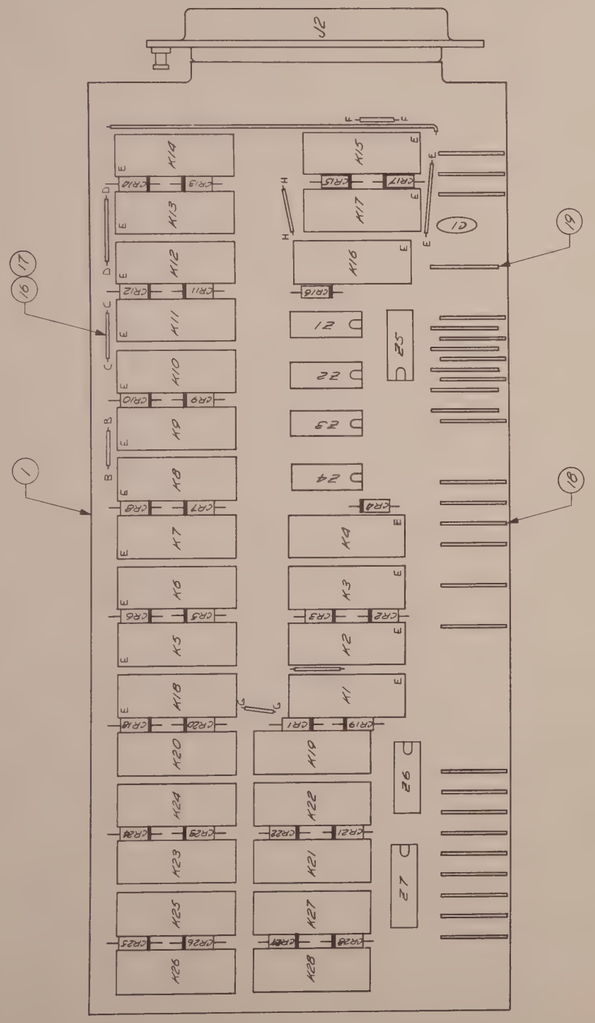
ASSEMBLY 68-6042

PARTS LIST

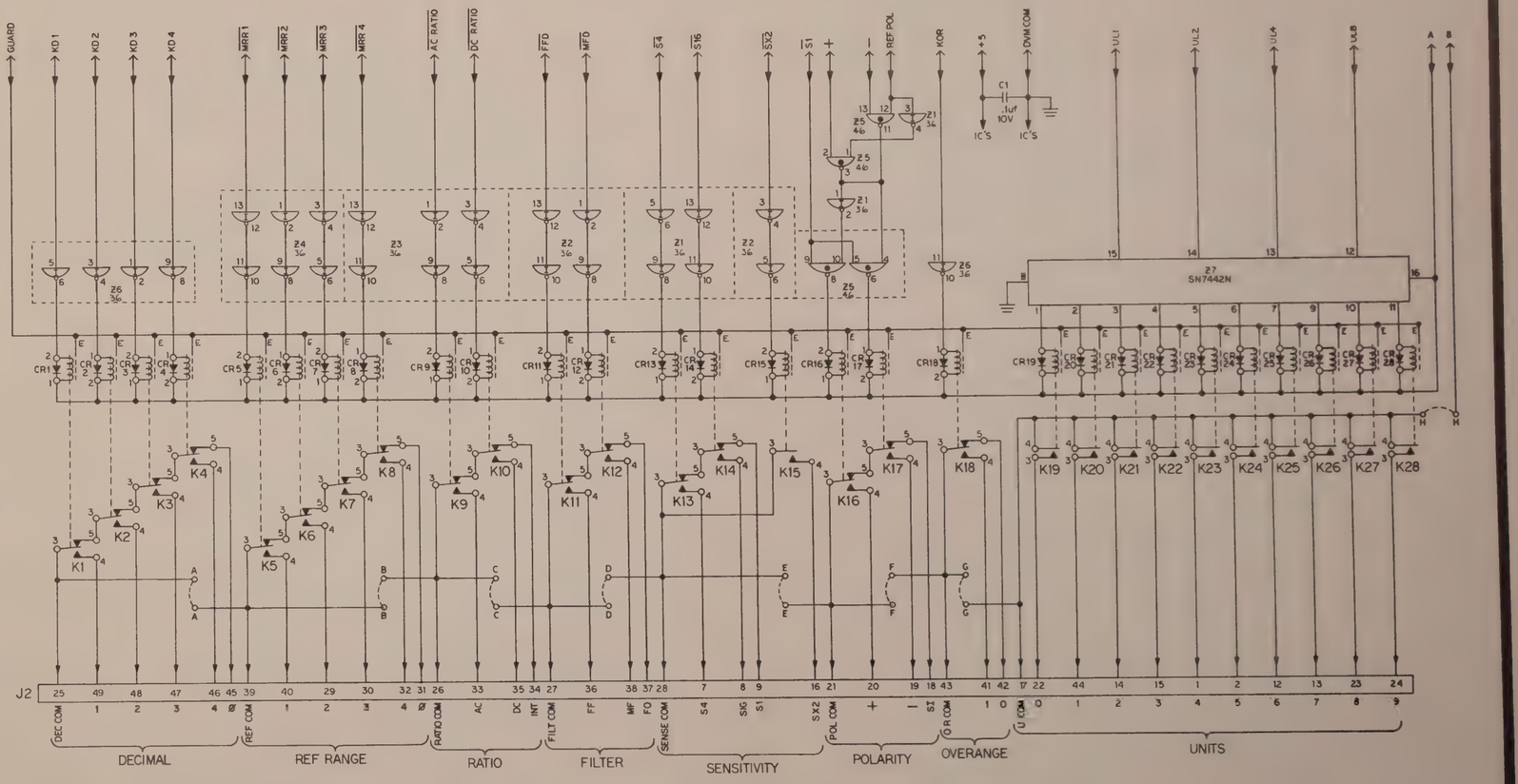
ASSEMBLY: Ten-Line Print Output No. 1 SCHEMATIC NO.: 68-0742 PART NO.: 68-6042

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 24)	CIMRON PART NO.	
1	1	ETCHED CIRCUIT BOARD		68-7042	
2					
3	1	CAP CER DISC 0.1 10V	C1	1-57525	
4					
5	1	CONN REC MIN 50 PIN	J2	67-0518	
6					
7	10	RELAY REED R2191-1	K19-K28	7-38228	
8	18	RELAY REED R2204-1	K1-K18	7-38231	
9					
10	28	DIODE	CR1-CR28	7-95647	
11					
12	1	INT CIRCUIT 846	Z5	7-96008	
13	1	INT CIRCUIT 7442	Z7	7-96046	
14	5	INT CIRCUIT 5836	Z1-Z4, Z6	7-96064	
15					
16	A/R	WIRE, COPPER TINNED, 24 GAUGE		9-81024	
17	A/R	TUBING, TEFLON, 24 GAUGE		9-07724	
18	23	ELECT CONT, LOWER		2-63904	
19	6	ELECT CONT, UPPER		2-63907	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



NOTES: UNLESS OTHERWISE SPECIFIED:
1. FOR SCHEMATIC SEE 68-0142
2. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A24



4. K1 THRU K18 ARE 8220.04-1 K19 THRU K28 ARE 2191-1
3. ALL DIODES ARE CIMRON P/N 7-95647
2. C1, CR28, K28, Z7

LAST NO. USED	NO. NOT USED

1. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A24

NOTES: UNLESS OTHERWISE SPECIFIED

5. FOR ASSEMBLY SEE 68-6042

Ten-Line Print Output No. 1.

TEN-LINE PRINT OUTPUT NO. 2

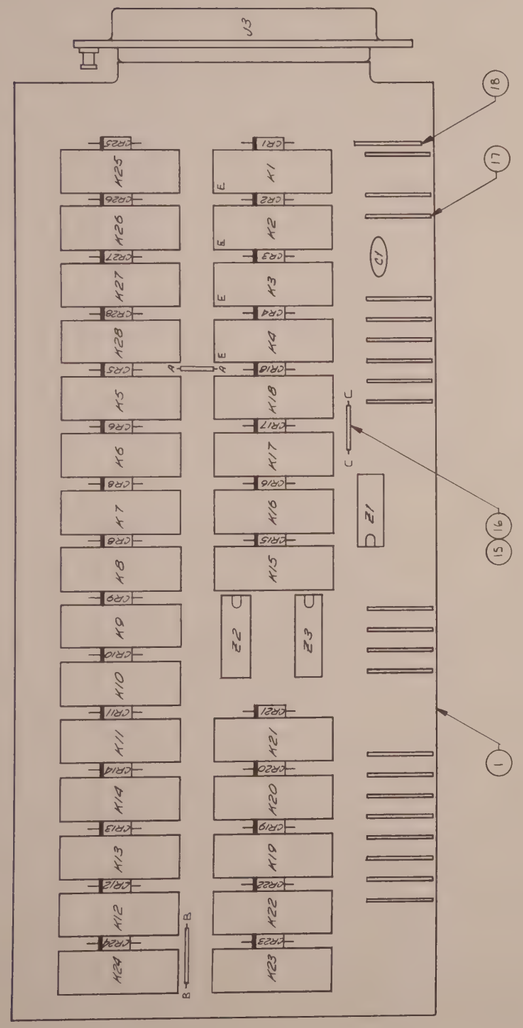
ASSEMBLY 68-6043

PARTS LIST

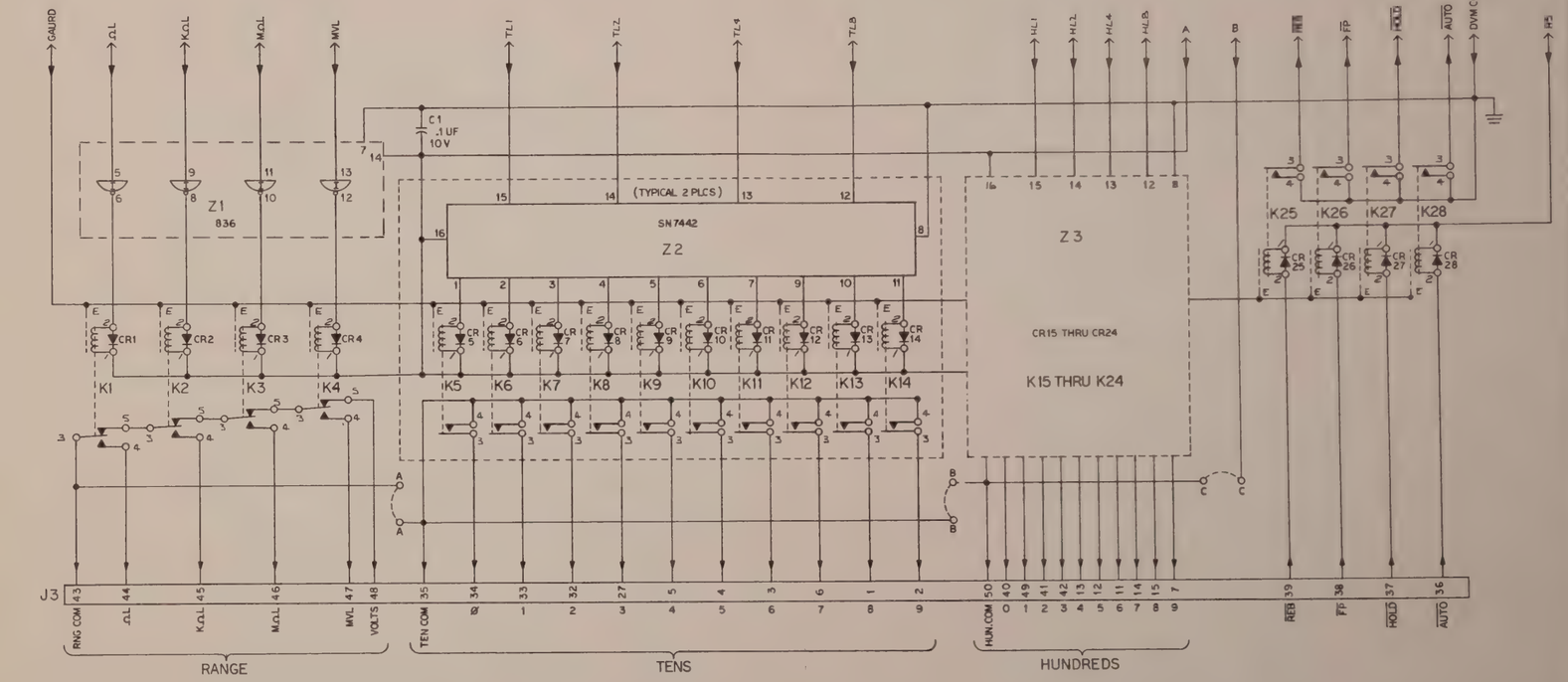
ASSEMBLY: Ten-Line Print Output No. 2 **SCHEMATIC NO.:** 68-0743 **PART NO.:** 68-6043

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A23)	CIMRON PART NO.	
1	1	ETCHED CIRCUIT BOARD		68-7043	
2					
3	1	CAP CER DISC 0.1 10V	C1	1-57525	
4					
5	1	CONN REC MIN 50 PIN	J3	67-0518	
6					
7	4	RELAY REED R2204-1	K1-K4	7-38231	
8	24	RELAY REED R2191-1	K5-K28	7-38228	
9					
10	28	DIODE	CR1-CR28	7-95647	
11					
12	1	INT CIRCUIT 836	Z1	7-96064	
13	2	INT CIRCUIT 7442	Z2, Z3	7-96046	
14					
15	A/R	WIRE, COPPER TINNED, 24 GAUGE		9-81024	
16	A/R	TUBING, TEFLON, 24 GAUGE		9-07724	
17	21	ELECT CONT, LOWER		2-63904	
18	1	ELECT CONT, UPPER		2-63907	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



NOTES ∿ UNLESS OTHERWISE SPECIFIED
1. FOR SCHEMATIC SEE 68-0743
2. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A23



5. FOR ASSEMBLY SEE DWG 68-6043
4. ALL DIODES ARE CIMRON P/N 7-93647
3. K1 THRU K4 ARE 82204, K5 THRU K28 ARE 82191
2. C1,CR28,K28,Z3 | LAST NO. USED | NO. NOT USED
1. PARTIAL REFERENCE DESIGNATIONS SHOWN, FOR COMPLETE DESIGNATOR PREFIX A2.3

NOTES: UNLESS OTHERWISE SPECIFIED:

Ten-Line Print Output No. 2.

6-173/174

TEN-LINE PRINT OUTPUT NO. 3

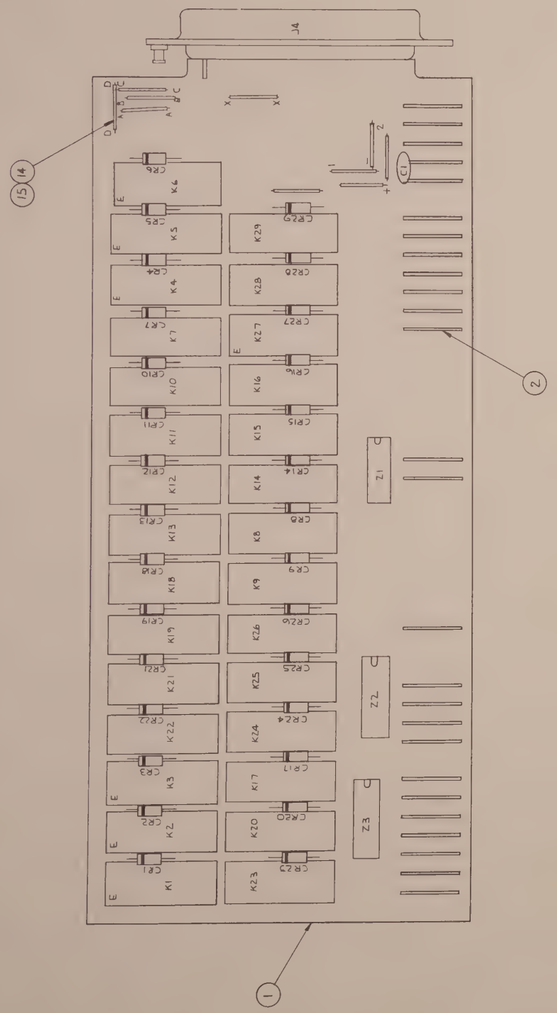
ASSEMBLY 68-6044

PARTS LIST

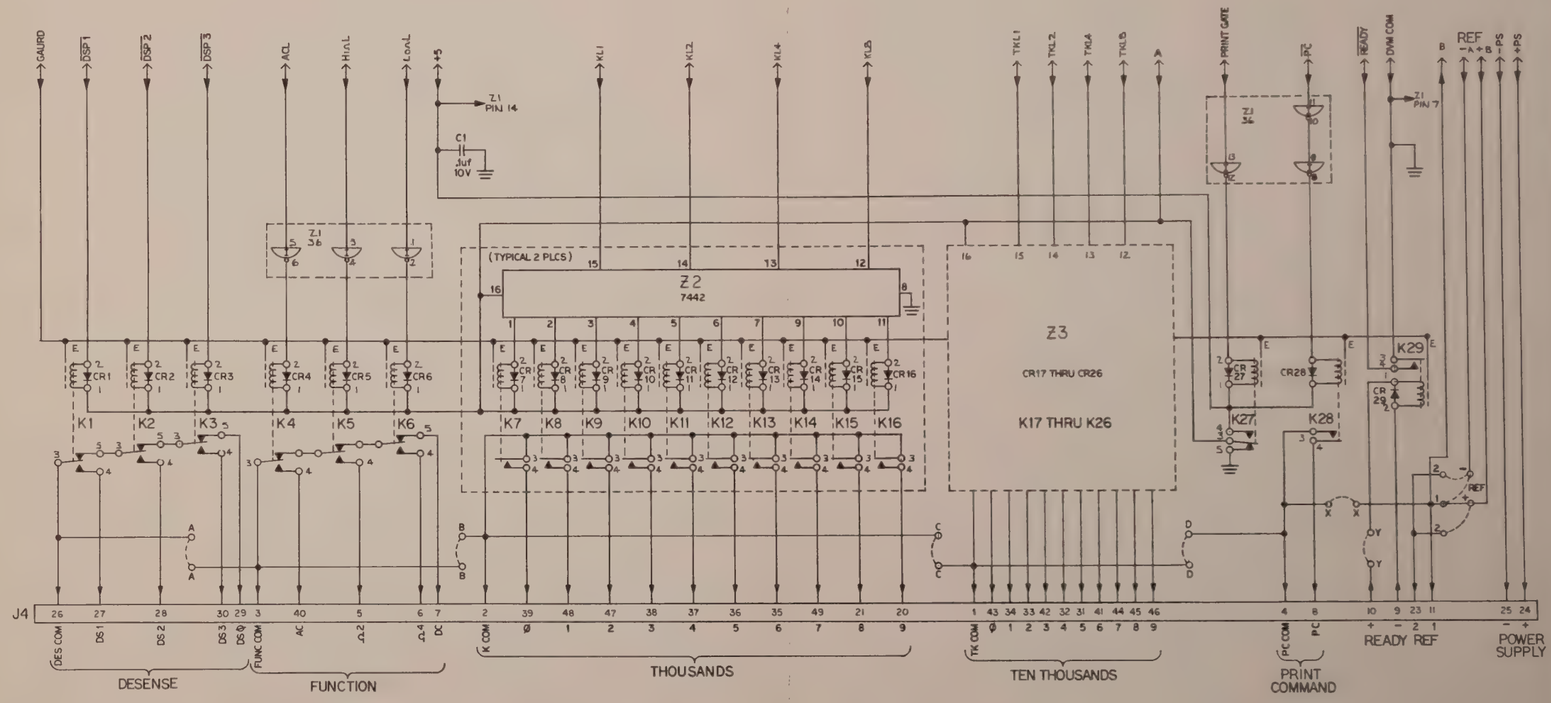
ASSEMBLY: Ten-Line Print Output No. 3 SCHEMATIC NO.: 68-0744 PART NO.: 68-6044

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A22)	CIMRON PART NO.	
1	1	ETCHED CIRCUIT BOARD		68-7044	
2	26	CONTACT ELECT		2-63904	
3					
4	1	CAP CER DISC 0.1 10V	C1	1-57525	
5					
6	22	RELAY REED R2191-1	K7-K26, K28, K29	7-38228	
7	7	RELAY REED R2204-1	K1-K6, K27	7-38231	
8					
9	29	DIODE	CR1-CR29	7-95647	
10					
11	2	INT CIRCUIT, 7442	Z2, Z3	7-96046	
12	1	INT CIRCUIT, 836	Z1	7-96064	
13					
14	A/R	TUBING NATURAL, 24 GAUGE		9-07722	
15	A/R	WIRE, COPPER TINNED, 24 GAUGE		9-81022	
16					
17	1	CONN REC MIN 50 PIN		67-0518	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



NOTES: UNLESS OTHERWISE SPECIFIED:
1. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A22.
2. FOR SCHEMATIC, SEE 68.0144.



NOTES: UNLESS OTHERWIS SPECIFIED:
5. K7 THRU K26, K28 & K29 ARE 82191-1
. K1 THRU K6 & K27 ARE 82204-1
4. DIODES ARE CIMRON P/N 7-95647
3. FOR ASSEMBLY SEE 68.6044
2. C1,CR29,K29,Z3 | LAST NO. USED | NO. NOT USED
1. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A22.

Ten-Line Print Output No. 3.

6-177/178

REMOTE BUFFER

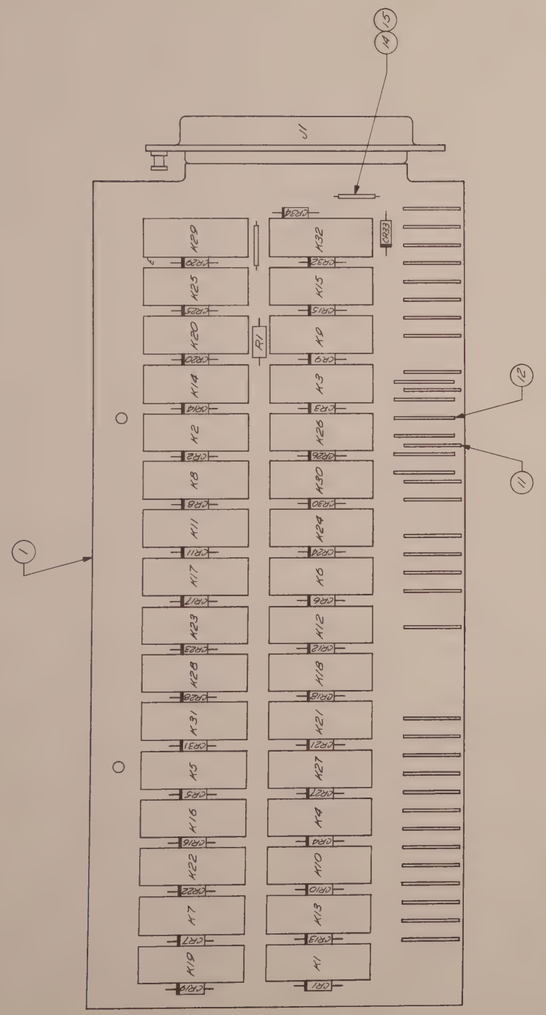
ASSEMBLY 68-6045

PARTS LIST

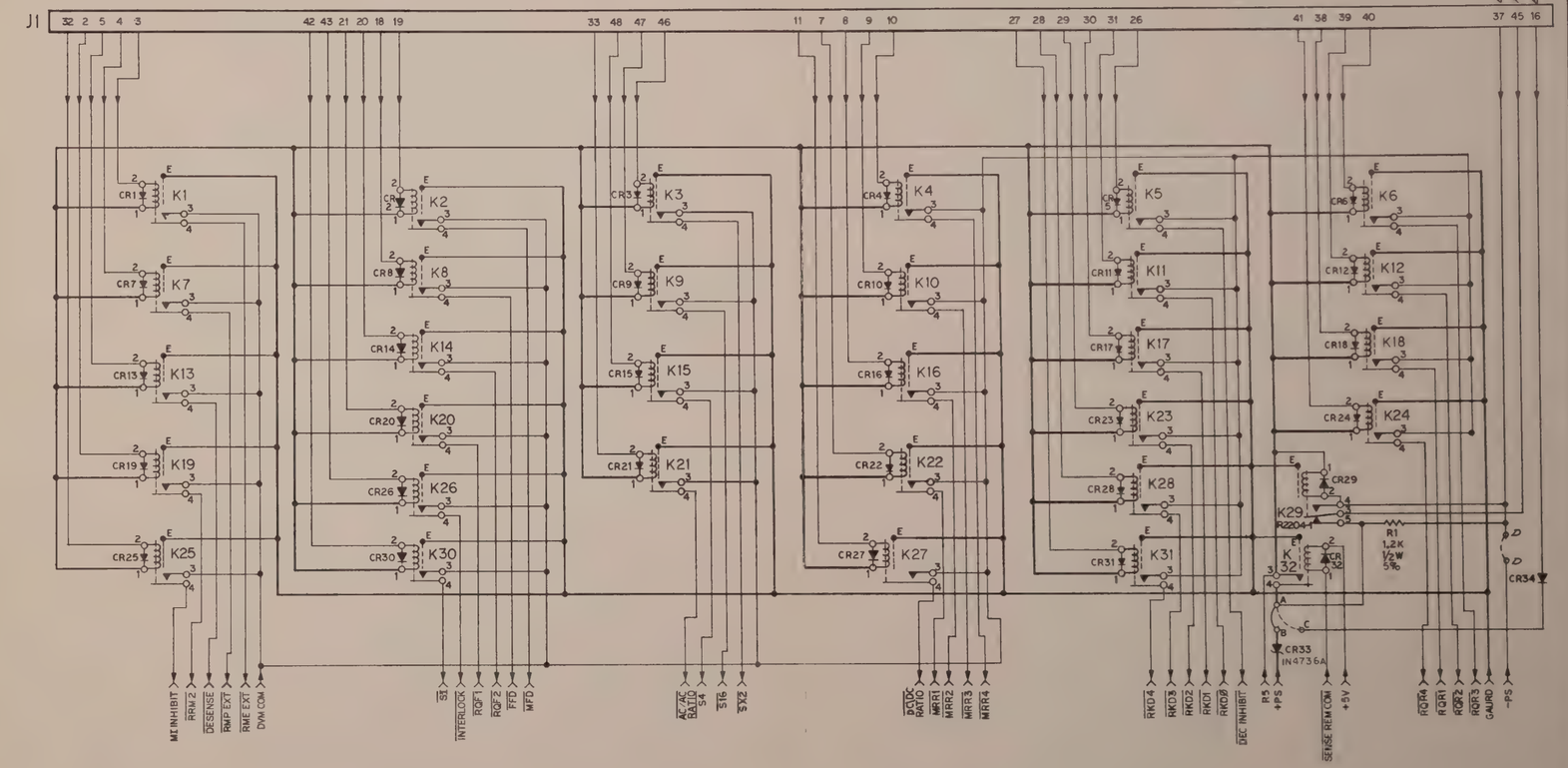
ASSEMBLY: Remote Buffer SCHEMATIC NO.: 68-0745 PART NO.: 68-6045

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A25)	CIMRON PART NO.	
1	1	ETCHED CIRCUIT BOARD		68-7045	
2					
3	33	DIODE	CR1-CR32, CR34	7-95647	
4	1	DIODE ZENER 1N4736A	CR33	7-95685	
5	1	MIN 50 PIN CONN. REC	J1	68-0518	
6	31	REED RELAY R2191-1	K1-K28, K30-K32	7-38228	
7	1	REED RELAY R2204-1	K29	7-38231	
8					
9	1	RESISTOR 1.2K 5% 1/2W	R1	7-41044	
10					
11	31	CONTACT ELECT, LOWER		2-63904	
12	6	CONTACT ELECT, UPPER		2-63907	
13					
14	A/R	WIRE, NO. 24 GAUGE		9-81024	
15	A/R	TUBING, NATURAL NO. 24 GAUGE		9-07724	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



NOTES: UNLESS OTHERWISE SPECIFIED:
1. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATIONS PREFIX A25
2. FOR SCHEMATIC DIAGRAM SEE 60-0745



NOTES: UNLESS OTHERWISE SPECIFIED:
7. ALL RELAYS ARE R2191-1
6. FOR ASSEMBLY SEE 68-6045
5. ALL DIODES ARE CIMRON P/N 7-95647
4. CR34 : K32 R1 | NONE
   LAST NUMBER USED | NUMBER NOT USED
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A25
2. ALL CAPACITORS ARE IN UF
1. ALL RESISTORS ARE IN OHMS, ±5%, ¼W

Remote Buffer.

6-181/182

REMOTE

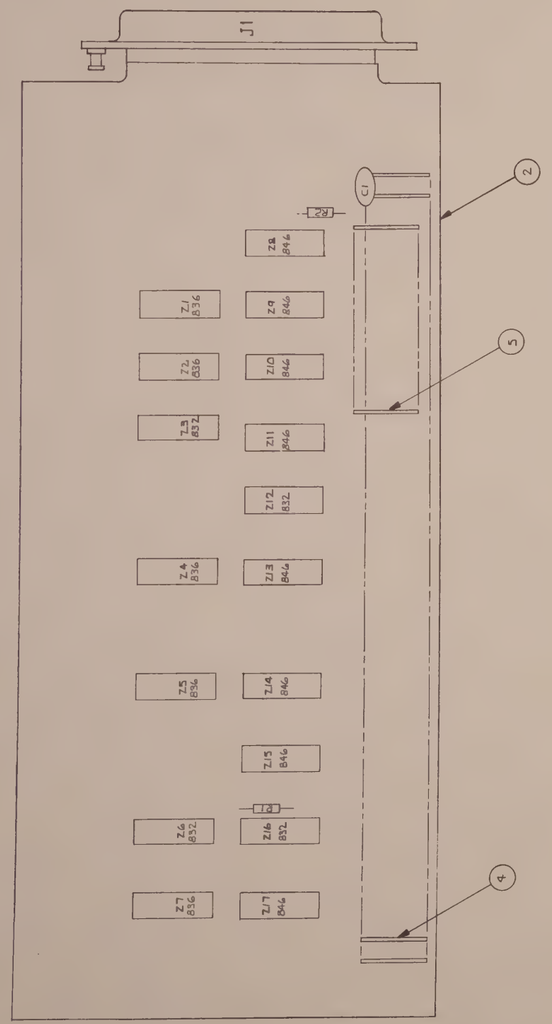
ASSEMBLY 68-6054

PARTS LIST

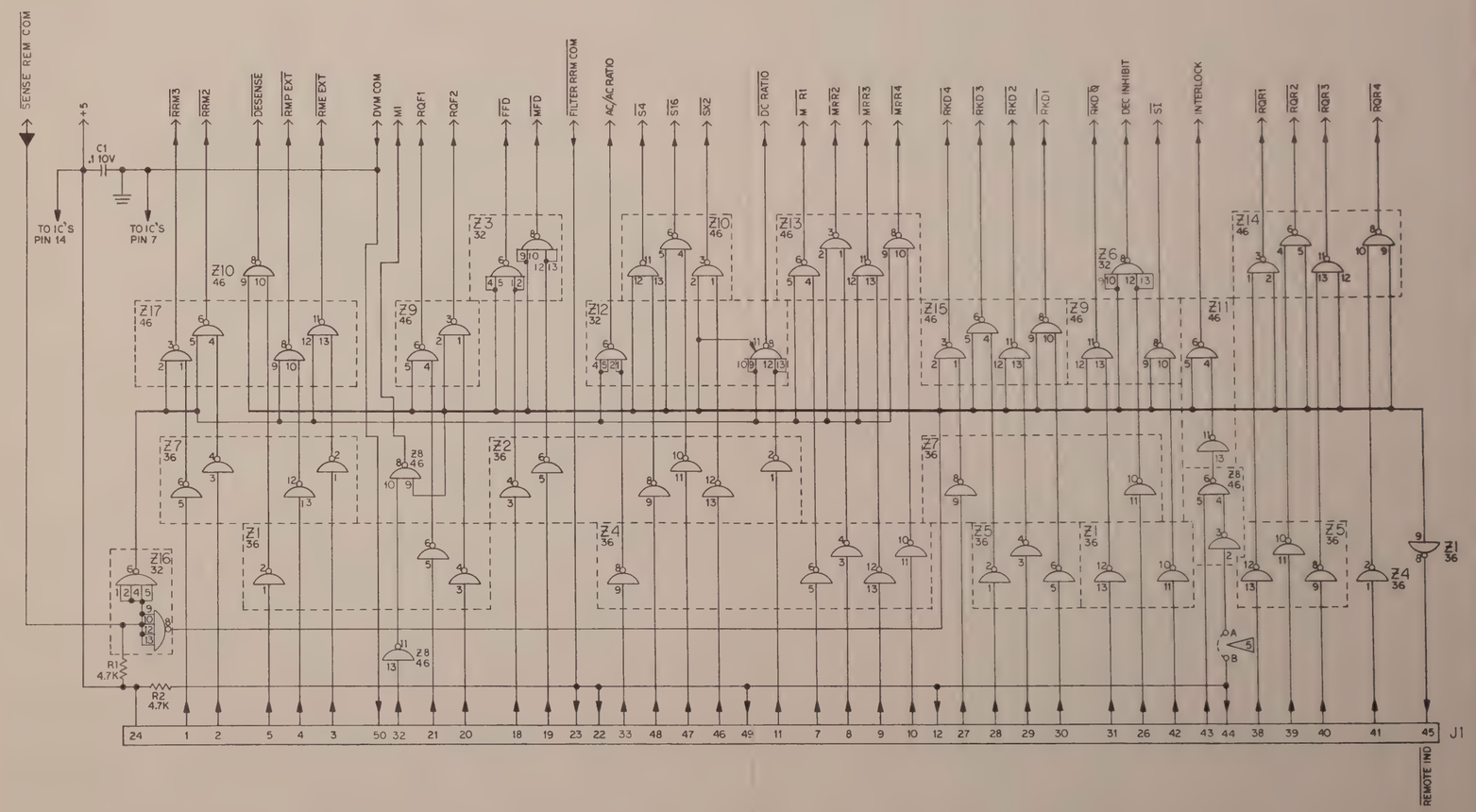
ASSEMBLY: Remote Assembly SCHEMATIC NO.: 68-0754 PART NO.: 68-6054

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 25)	CIMRON PART NO.	
1	1	ETCHED CIRCUIT BOARD		68-7054	
2	28	CONTACT ELECT		2-63904	
3	7	CONTACT ELECT		2-63907	
4					
5	1	CAP CER DISC .1 10V	C1	1-57525	
6					
7	2	RESISTOR COMP 4.7K	R1, R2	7-41251	
8					
9	4	AMPLIFIER MC832P	Z3, Z6, Z12, Z16	7-96004	
10	8	AMPLIFIER MC846P	Z8-Z11, Z13-Z15, Z17	7-96008	
11	5	AMPLIFIER SN15836N	Z1, Z2, Z4, Z5, Z7	7-96064	
12					
13	A/R	TUBING NATURAL NO. 24		9-07724	
14					
15	1	CONNECTOR, 50 PIN MODIFIED	J1	67-0518-1	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



4. FOR SCHEMATIC SEE 68-01154
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A25
2. ALL CAPACITORS ARE IN uf
1. ALL RESISTORS ARE IN OHMS, ± 5% 1/4W
NOTES: UNLESS OTHERWISE SPECIFIED



5 JUMPER NOT NORMALLY INSTALLED
4. C1, J1, R2, Z17

LAST NUMBER USED	NUMBER NOT USED

3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A25
2. ALL CAPACITORS ARE IN uf
1. ALL RESISTORS ARE IN OHMS, ±5%, 1/4W

NOTES: UNLESS OTHERWISE SPECIFIED:

Remote.

6-185/186

POWER SUPPLY

ASSEMBLY 68-6036

PARTS LIST

ASSEMBLY: Power Supply SCHEMATIC NO.: 68-0736 PART NO.: 68-6036

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 16)	CIMRON PART NO.	
1	1	CIRCUIT BOARD, ETCHED		68-7036	
2	1	SHIELD, POWER SUPPLY		68-2031-1	
3	26	CONTACT, ELECT		2-63904	
4	18	CONTACT, ELECT		2-63907	
5					
6	5	INSULATOR, TRANSISTOR PAD		5-07106	
7	4	SCREW, RD HD NO. 4-40 x 1/4		7-89104-4	
8	4	TERMINAL, TURRET		8-91110	
9	4	WASHER, LOCK INT TOOTH NO. 4		9-52504	
10					
11					
12					
13					
14	1	CAPACITOR, TANT 2.2 35V	C2	1-57104	
15	3	CAPACITOR, TANT 10 20V	C8, C10, C19	1-57112	
16	1	CAPACITOR, ELECT 200 15V	C12	1-57248	
17	2	CAPACITOR, ELECT 50 50V	C11, C20	1-57257	
18	2	CAPACITOR, ELECT 1100 50V	C1, C13	1-57275	
19	3	CAPACITOR, PAPER 0.033 100V	C4, C5, C14	1-57409	
20	3	CAPACITOR, SIL MICA 50 pF	C7, C9, C18	1-57487	
21	1	CAPACITOR, CER DISC 0.1 50V	C6	1-57529	
22	1	CAPACITOR, ELECT 100 250V	C15,	1-59019	
23	4	CHOKE 100 μH	L1, L2, L3, L4	1-90007	
24					
25					
26	1	TEST JACK, PC - RED	TP2	5-19002	
27	1	TEST JACK, PC - BROWN	TP1	5-19004	
28	1	TEST JACK, PC - GREEN	TP5	5-19005	
29	1	TEST JACK, PC - ORANGE	TP3	5-19006	
30	1	TEST JACK, PC - BLUE	TP6	5-19007	
31	1	TEST JACK, PC - YELLOW	TP4	5-19008	
32					
33	1	RESISTOR, COMP 470 ±5% 1/2W	R22	7-41039	
34	1	RESISTOR, COMP 680 ± 5% 1/2W	R29	7-41041	
35	1	RESISTOR, COMP 100K ±5% 1/2W	R21	7-41067	
36	1	RESISTOR, COMP 39	R3	7-41226	
37	1	RESISTOR, COMP 68	R1	7-41229	
38	2	RESISTOR, COMP 82	R5, R17	7-41230	

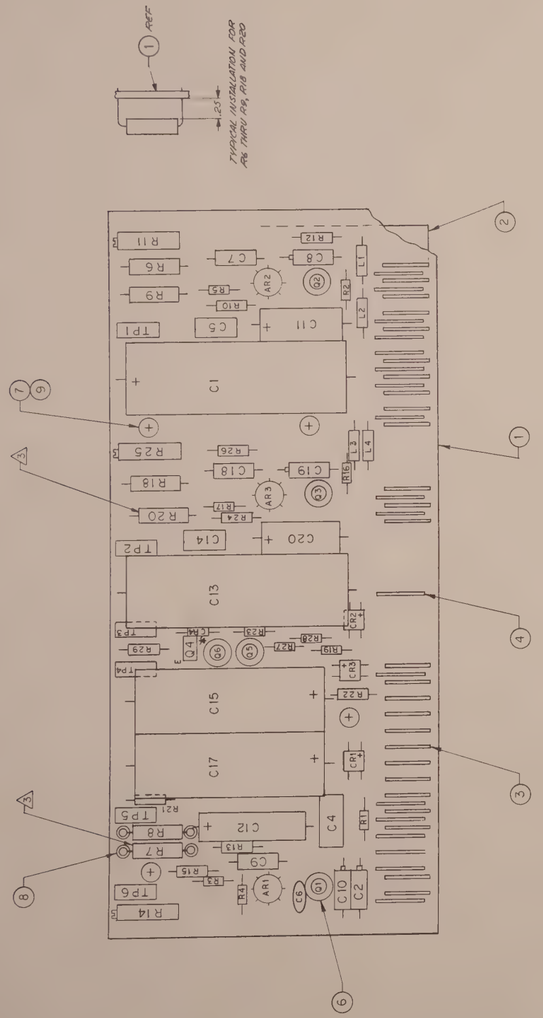
NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.

PARTS LIST

ASSEMBLY: Power Supply SCHEMATIC NO.: 68-0736 PART NO.: 68-6036

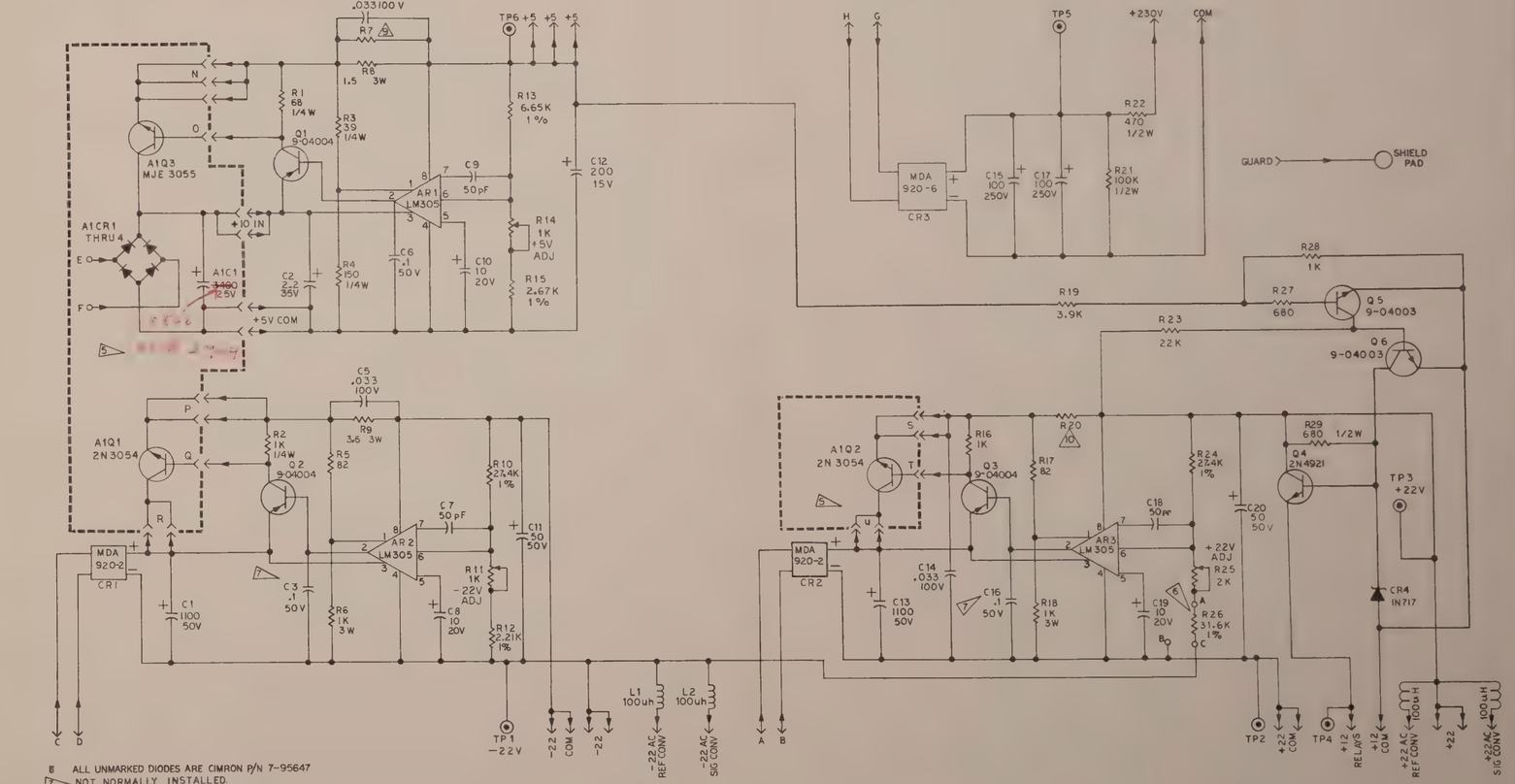
ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 16)	CIMRON PART NO.	
39	1	RESISTOR, COMP 150	R4	7-41233	
40	1	RESISTOR, COMP 680	R27	7-41241	
41	3	RESISTOR, COMP 1K	R2, R16, R28	7-41243	
42	1	RESISTOR, COMP 3.9K	R19	7-41250	
43	1	RESISTOR, COMP 22K	R23	7-41259	
44					
45	1	RESISTOR, T.O. 2.21K ±1% 1/4W	R12	7-46710	
46	1	RESISTOR, T.O. 2.67K ±1% 1/4W	R15	7-46766	
47	1	RESISTOR, T.O. 6.65K ±1% 1/4W	R13	7-46783	
48	2	RESISTOR, T.O. 27.4K ±1% 1/4W	R10, R24	7-46791	
49	1	RESISTOR, T.O. 31.6K ±1% 1/4W	R26	7-46868	
50	2	RESISTOR, WW 1K ±5% 3W	R6, R18	7-47140	
51	1	RESISTOR, WW 1.5 ±5% 3W	R8	7-47370	
52	1	RESISTOR, WW 3.6 ±5% 3W	R9	7-47371	
53	1	RESISTOR, VAR 2K	R25	7-54284	
54	2	RESISTOR, VAR 1K	R11, R14	7-54305	
55					
56	1	DIODE MDA-920-6	CR3	7-95516	
57	1	DIODE ZENER 1N717A	CR4	7-95635	
58	2	DIODE MDA-920-2	CR1, CR2	7-95660	
59	3	VOLTAGE REGULATOR LM 305	AR1, AR2, AR3	7-96070	
60					
61	2	TRANSISTOR NPN	Q5, Q6	9-04003	
62	3	TRANSISTOR PNP	Q1, Q2, Q3	9-04004	
63	1	TRANSISTOR 2N4921	Q4	9-04760	
64					
65	1	RESISTOR, FACTORY SELECTED VALUE	R7		
66	1	RESISTOR, FACTORY SELECTED VALUE	R20		

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.



⚠ SELECTED VALUE
2 FOR SCHEMATIC DIAGRAM SEE 68-0736
1. PARTIAL REFERENCE DESIGNATIONS SHOWN. FOR COMPLETE DESIGNATOR PREFIX A16

NOTES: UNLESS OTHERWISE SPECIFIED.



NOTES:
1. ALL CAPACITOR ARE IN uF
2. ALL RESISTORS ARE IN OHMS ±5% 1/4W
3. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATOR PREFIX A16
4. LAST NUMBER USED | NUMBER NOT USED
   TP6, CR4
   R29, C20, Q6, AR3
5. MTD ON CHASSIS OR MASTER CKT BD
6. 31.6K A, C, FOR TRACKING OPERATION
   2.2K A, B, FOR SEPARATE OPERATION
7. NOT NORMALLY INSTALLED.
8. ALL UNMARKED DIODES ARE CIMRON P/N 7-95647

⚠10 SELECTED VALUE NOMINALLY 3Ω.
⚠9 SELECTED VALUE, NOMINALLY 1Ω.

Power Supply.

6-191/192

MASTER ASSEMBLY

PARTS LIST

ASSEMBLY: End Item PART NO.: 68-1000

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A1)	CIMRON PART NO.	
1	1	MAIN CHASSIS ASSY.		68-5004	
2	1	FRONT PANEL ASSY.		68-5006-1	
3	1	REAR PANEL ASSY.		68-5007-1	
4					
5	1	SHIELD - TOP		68-2045-1	
6	1	SHIELD - BOTTOM		68-2014-1	
7					
8	2	INSULATOR - SIDE PANEL		68-2032-1	
9	1	COVER - REAR PANEL		68-2044-1	
10					
11					
12	2	GUIDE - BOTTOM		00-2000-1	
13	2	GUIDE - TOP		00-2001-1	
14	2	BRACKET - RACK MOUNTING		00-2002-1	
15	2	SIDE PANEL 18"		00-2003-1	
16	2	COVER - FRONT		00-2005-3	
17	2	HANDLE		00-2007-1	
18	2	COVER - REAR		00-2009-1	
19	2	COVER ASSY.		00-2011-1	
20	2	LATCH		00-2012-1	
21	2	COVER - SIDE		00-2013-3	
22	2	SPRING LATCH		00-0503-1	
23					
24	1	COMPARATOR, 1K and 10K DECODER ASSY.	A10, A11, A17	68-5008-1	
25	1	FILTER AND INPUT AMPLIFIER ASSY.	A18, A19	68-5009-1	
26	1	TENS, HUNDREDS DECADE ASSY.	A7	67-6087-1	
27	1	1K, 10K DECADE ASSY.	A8	67-6088-1	
28	1	UNITS, TENS, HUNDREDS DECODER ASSY.	A9	67-6089-1	
29					
30	1	DISPLAY DRIVER ASSY.	A3	68-6032-1	
31	1	FUNCTION DECIMAL ASSY.	A4	68-6033-1	
32	1	AUTORANGE ASSY.	A5	68-6034-1	
33					
34	1	POWER SUPPLY ASSY.	A16	68-6036-1	
35	1	REFERENCE AMPLIFIER ASSY.	A20	68-6040-1	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.

PARTS LIST

ASSEMBLY: End Item				PART NO.: 68-1000	
ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A1)	CIMRON PART NO.	
36	1	UNITS DECADE & CONTROL LOGIC ASSY.	A6	68-6046-1	
37	1	CABLE ASSY. - SIGNAL		68-5013-1	
38	1	TOOL EXTRACTION		70-9500-1	
39	1	KNOB		5-42006	
40	1	BAIL 16"		8-16504	
41	1	CABLE ASSY. - REFERENCE		68-5014-1	
42					
43	4	SCREW 6-32 x 1/2 TRUSS HD		7-89206-8	
44	8	SCREW 10-32 x 3/8 NYLON FILL HD		7-86011-6	
45	4	SCREW 10-32 x 3/8 NYLON FLAT HD		7-87011-6	
46	4	SCREW 6-32 x 3/16 FLAT HD		7-89006-3	
47	2	SCREW 8-32 x 3/8 FLAT HD		7-89008-6	
48	4	SCREW 3-48 x 3/16 ROUND HD		7-89103-3	
49	13	SCREW 4-40 x 1/4 TRUSS HD		7-89204-4	
50					
51	6	SCREW 4-40 x 3/8 TRUSS HD		7-89204-6	
52	4	SCREW 6-32 x 1/4 TRUSS HD		7-89206-4	
53	8	SCREW 8-32 x 1/4 TRUSS HD		7-89208-4	
54	6	SCREW 8-32 x 3/8 TRUSS HD		7-89208-6	
55	4	SCREW 6-32 x 1/2 OVAL HD		7-89306-8	
56	2	SCREW 8-32 x 5/16 100° FLAT HD		7-88908-5	
57	2	SCREW 10-32 x 3/8 TRUSS HD		7-89210-6	
58	13	LOCKWASHER NO. 4 INT TOOTH		9-52504	
59	14	LOCKWASHER NO. 8 INT TOOTH		9-52508	
60	12	WASHER FLAT NYLON NO. 10 x .031 TH x .375 DIA		9-53103	
61	4	LOCKWASHER NO. 6 INT TOOTH		9-52506	
62	4	WASHER, FLAT, STEEL #10		9-51510-2	
63					
		OPTIONAL EQUIPMENT			
64	1	COVER - REAR PANEL		68-2044-3	
65	1	COVER - REAR PANEL		68-2044-5	
66					
67	1	INPUT SELECTOR ASSY.	A15	68-6035-1	
68	1	PRINT CONTROL ASSY.	A21	68-6041-1	
69	1	PRINTOUT ASSY. - 10 LINE	A22, A23, A24	68-5014-1	
70					

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.

PARTS LIST

ASSEMBLY: End Item				PART NO.: 68-1000	
ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A1)	CIMRON PART NO.	
		OPTIONAL EQUIPMENT (CONT.)			
71					
72	1	REMOTE BUFFER ASSEMBLY	A25	68-6045-1	
73	1	PRINTOUT ASSEMBLY - 1248 CONTACT CLOSURE	A22, A23, A24	68-5015-1	
74					
75					
76					
77	1	PRINTOUT ASSEMBLY - 1248 DTL	A22, A23, A24	68-5013-1	
78	1	REMOTE ASSEMBLY	A25	68-6054-1	
79					
80	1	PRINTOUT ASSEMBLY - 1248 VOLT ST. NEG	A22, A23, A24	68-5016-1	
81					
82	1	100 MΩ RANGE ASSEMBLY	A26	68-6058-1	
83					
84	1	PRINTOUT ASSEMBLY - 1248 VOLT STATE POS	A22, A23, A24	68-5017-1	
85					
86	2	AC CONVERTER MODEL 5775	A13R, A13S	57-6000-7	
87	1	LOW OHMS CONVERTER MODEL 5891	A14	58-6014-1	
88	1	HIGH OHMS/MV CONVERTER MODEL 5889	A12	58-6015-1	
89					
90	1	CABLE - REAR INPUT CONNECTOR	J5, J6	68-5018-1	
91	1 Pr.	RACK SLIDE 18"		00-5003-1	
92	1	100V DC RATIO REF OPTION		68-5019-1	
94	2	RMS CONVERTER MODEL 5877	A13R, A13S	57-6001-003	
ASSEMBLY: Main Chassis Assembly				PART NO.: 68-5004	
1	1	FRAME SUBASSEMBLY		68-5005	
2	1	MASTER CIRCUIT BOARD SUBASSEMBLY		68-6030-1	
3	1	SHIELD SIDE LEFT		68-2022-1	
4	1	SHIELD SIDE RIGHT		68-2023-1	
5	1	HEATSINK POWER TRANSISTORS SUBASSEMBLY		68-5010-1	
6					

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.

PARTS LIST

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A1)	CIMRON PART NO.	
ASSEMBLY: Main Chassis Assembly				**PART NO.:** 68-5004	
7					
8					
9					
10	A/R	NUT CAPTIVE ALUM 4-40		6-36708	
11	4	SCREW 6-32 x 5/16 LG 100° FLAT HD		7-88906-5	
12	8	SCREW 8-32 x 5/16 LG 100° FLAT HD		7-88908-5	
13	A/R	SCREW 4-40 x 1/4 LG TRUSS HD		7-89204-4	
14	2	SCREW 10-32 x 3/8 LG TRUSS HD		7-89210-6	
15					
16					
17	A/R	LOCKWASHER NO. 4 INT TOOTH		9-52504	
18	2	LOCKWASHER NO. 10 INT TOOTH		9-52510	
ASSEMBLY: Frame Subassembly				**PART NO.:** 68-5005	
1	1	TRACK - FRONT		68-2015	
2	1	TRACK - CENTER		68-2016-1	
3	1	TRACK - SIDE RIGHT		68-2019-1	
4	2	TRACK - SUB		68-2021-1	
5	1	SHIELD - CENTER		68-2024-1	
6	1	TRACK - REAR		68-2037-1	
7	1	TRACK - REAR LEFT		68-2038-1	
8	1	TRACK - SIDE LEFT		68-2041-1	
9					
10	2	SHIELD - CENTER		67-2020-3	
11	1	STRAP - TOOL HOLDER		70-3005-3	
12					
13					
14					
15	4	NUT PLASTIC 212-160404-08		6-36707	
16	28	RIVET BLIND AL 5/32 DIA AA-53D		7-67008	
17	2	SCREW 4-40 x 1/4 TRUSS HD		7-89204-4	
18	2	LOCKWASHER NO. 4 INT TOOTH		9-52504	
ASSEMBLY: Master Circuit Board Subassembly				**PART NO.:** 68-6030	
1	1	MASTER CIRCUIT BOARD		68-7030	
2	1	POWER TRANSFORMER	T1	68-0503-1	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.

PARTS LIST

ASSEMBLY: Master Circuit Board Subassembly				PART NO.: 68-6030	
ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A 1)	CIMRON PART NO.	
3	1	SWITCH & REP MODE POT	S1, R1	66-0507-1	
4					
5	1	CAP M PAP 10 100V	C2	1-57341	
6	1	CAP ELECT 3800 25V	C1	1-58024	
7	2	RES COMP 100K 5% 1/2W	R5, R6	7-41067	
8	1	RES VAR 20K	R2	7-54315	
9	2	RES VAR 50K	R3, R4	7-54316	
10	7	DIODE 1N914	CR1-CR7	7-95647	
11	4	DIODE 3SM2	CR8-CR11	7-95702	
12	10	LAMP SOCKET	XDS1-XDS10	8-24112	
13	1	SWITCH PUSHBUTTON 7 SECT 2 POLE "F"	S3	8-64146	
14	1	SWITCH PUSHBUTTON 9 SECT 2 POLE "F"	S2 (REF S2A & S2B)	8-64147	
15	1	SWITCH PUSHBUTTON 7 SECT 2 POLE "F"	S4 (REF S4A & S4B)	8-64180	
16	1	SWITCH PUSHBUTTON 1 SECT 6 POLE "F"	S7	8-64181	
17	1	SWITCH POWER SPST	S5	8-64149	
18					
19	674	CONTACT ELECT 5201-0223		2-63905	
20					
21	4	SCREW 10-32 x 3/8 LG TRUSS HD		7-89210-6	
22	5	STANDOFF 4-40 x 3/8		8-29521	
23	1	TERMINAL		8-91110	
24	4	LOCKWASHER NO. 10		9-52510	
25	7	SCREW, 3-48 x 3/16		7-89103-3	
26	A/R	WIRE 3 COND SHIELDED NO. 26 GAUGE		9-80003	
27	A/R	WIRE SINGLE COND SHIELDED NO. 24 GAUGE		9-80004	
28	A/R	WIRE 2 COND SHIELDED NO. 24 GAUGE		9-80005	
29	A/R	WIRE SINGLE COND SHIELDED TEFLON LGE NO. 24 GAUGE		9-80014	
30	A/R	WIRE SINGLE COND SHIELDED TEFLON SML NO. 24 GAUGE		9-80015	
31					

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.

PARTS LIST

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A1)	CIMRON PART NO.	
ASSEMBLY: Master Circuit Board Subassembly				**PART NO.:** 68-6030	
32	A/R	WIRE INSULATED 22 GA. RED		9-82202	
33	A/R	WIRE INSULATED 22 GA YELLOW		9-82204	
34	A/R	WIRE INSULATED 22 GA GREEN		9-82205	
35	A/R	WIRE INSULATED 22 GA WHITE		9-82209	
36					
37	A/R	WIRE 1000V 22 GA TEFLON INSULATED		9-83000	
ASSEMBLY: Heatsink—Pwr. Transistor Subassembly				**PART NO.:** 68-5010	
1	1	HEATSINK—PWR TRANSISTORS		68-2033	
2	2	TRANSISTOR 2N3054	Q1, Q2	9-04739	
3	1	TRANSISTOR MJE 3055	Q3	9-04782	
4	1	SCREW 6-32 x 1/4 NYLON BINDER HD		7-86006-4	
5	2	TERMINAL SOLDER LUG		8-90806-1	
6	4	WASHER – LOCK NO. 4		9-52504	
ASSEMBLY: Panel Assembly – Front				**PART NO.:** 68-5006	
1	1	PANEL – FRONT		68-2043	
2					
3	1	POLARIZER		67-2050-1	
4					
5	10	CLIP "C" - LAMP MOUNTING		2-05004	
6	10	LAMP 6V 40 MIL	DS1-DS10	5-46507	
7	1	BANANA JACK NYLON BLACK	E2	6-94013	
8	1	BANANA JACK NYLON RED	E1	6-94014	
9	1	BANANA JACK NYLON GREEN	E3	6-94015	
10	1	BANANA JACK NYLON YELLOW	E4	6-94016	
11	1	BANANA JACK NYLON BLUE	E5	6-94017	
12	1	BANANA JACK GROUND	E6	6-94018	
13					
14					
15		WIRE 2 COND DOUBLE SHIELDED		9-80001	
16	1	BUSHING NYLON SNAP		1-25901	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.

PARTS LIST

ASSEMBLY: Panel Assembly - Rear PART NO.: 68-5007

ITEM NO.	QTY REQD	DESCRIPTION	SCHEM DES (ADD PREFIX A1)	CIMRON PART NO.	
1	1	PANEL - REAR		68-2012	
2	1	POWER CORD		2-70004	
3	1	FUSE 3AG SLO-BLO 1 A	F1	4-08017	
4	1	FUSE HOLDER	XF1	4-12000	
5	1	STRAIN RELIEF - POWER CORD		4-35000	
6	2	HOLE PLUG-SNAP 7/8 DIA		6-88002	
7	1	RETAINER - CKT BD		68-2025-1	
8	1	SWITCH SLIDE 115/230V DPDT	S6	8-65004	
9					
10					
11	3	NUT HEX 4-40		6-36504-6	
12	5	SCREW 4-40 x 1/4 LG TRUSS HD		7-89204-4	
13	2	TERMINAL SOLDER LUG		8-90806-1	
14	2	LOCKWASHER NO. 4 INT TOOTH		9-52504	

NOTE: Unless otherwise specified, all resistors are in ohms, ±5%, 1/4W. All capacitors are in microfarads.

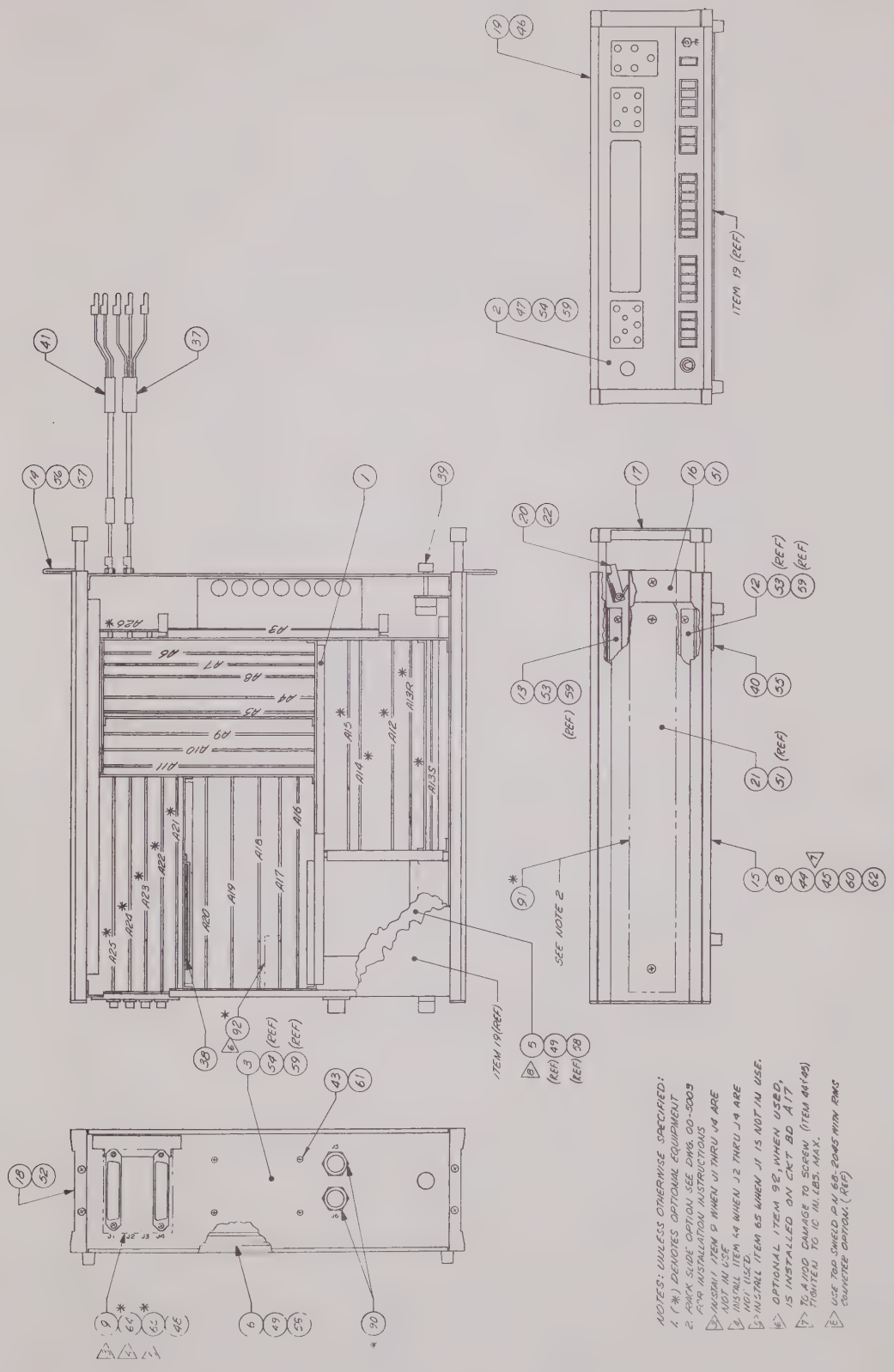

ITEM 19 (REF)
SEE NOTE 2
ITEM 19 (REF)
NOTES: UNLESS OTHERWISE SPECIFIED:
1. (*) DENOTES OPTIONAL EQUIPMENT
2. PARK SLIDE OPTION SEE DWG. 00-3009 FOR INSTALLATION INSTRUCTIONS
3. INSTALL ITEM 9 WHEN W1 THRU W4 ARE NOT IN USE
4. INSTALL ITEM 44 WHEN J2 THRU J4 ARE NOT IN USE
5. INSTALL ITEM 65 WHEN J1 IS NOT IN USE.
6. OPTIONAL ITEM 92, WHEN USED, IS INSTALLED ON CKT BD A17.
7. TO AVOID DAMAGE TO SCREW (ITEM 44 & 45) TIGHTEN TO 10 IN. LBS. MAX.
8. USE 700 SHIELD P/N 68-2045 WITH EMS COUNTER OPTION. (REF)

Figure 6-7. End Item.

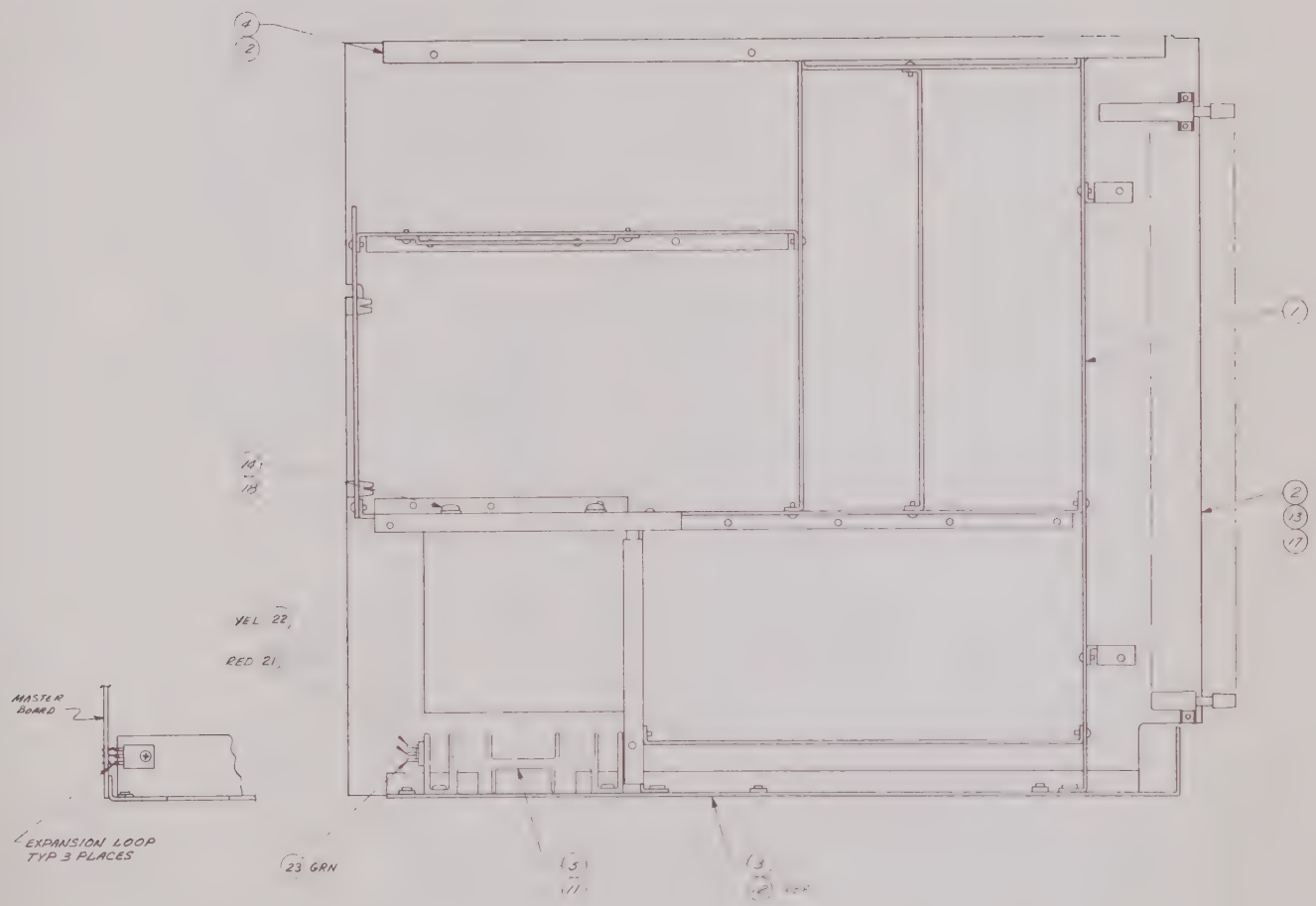


Figure 6-8. Main Chassis Assembly.

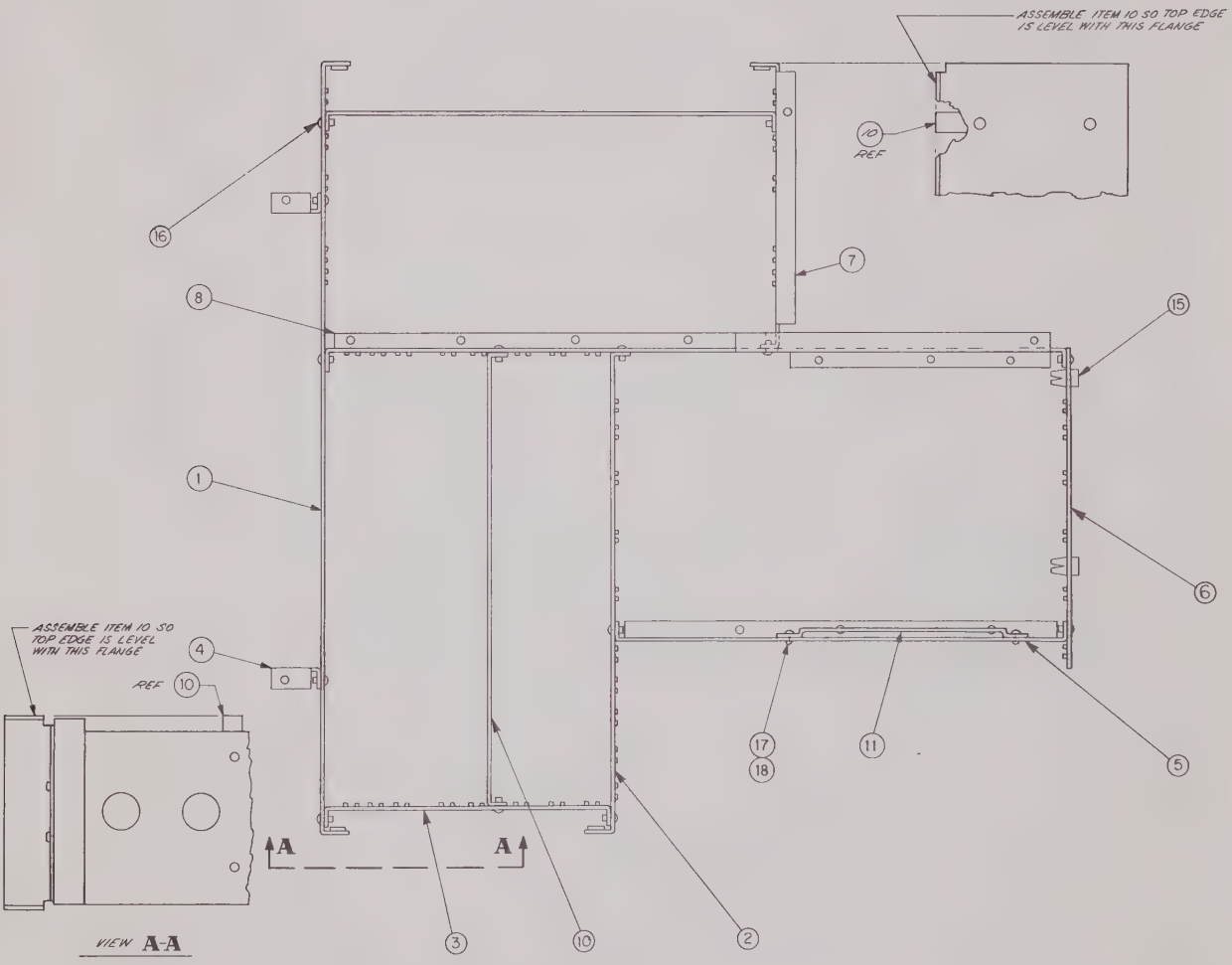


Figure 6-9. Frame Subassembly.

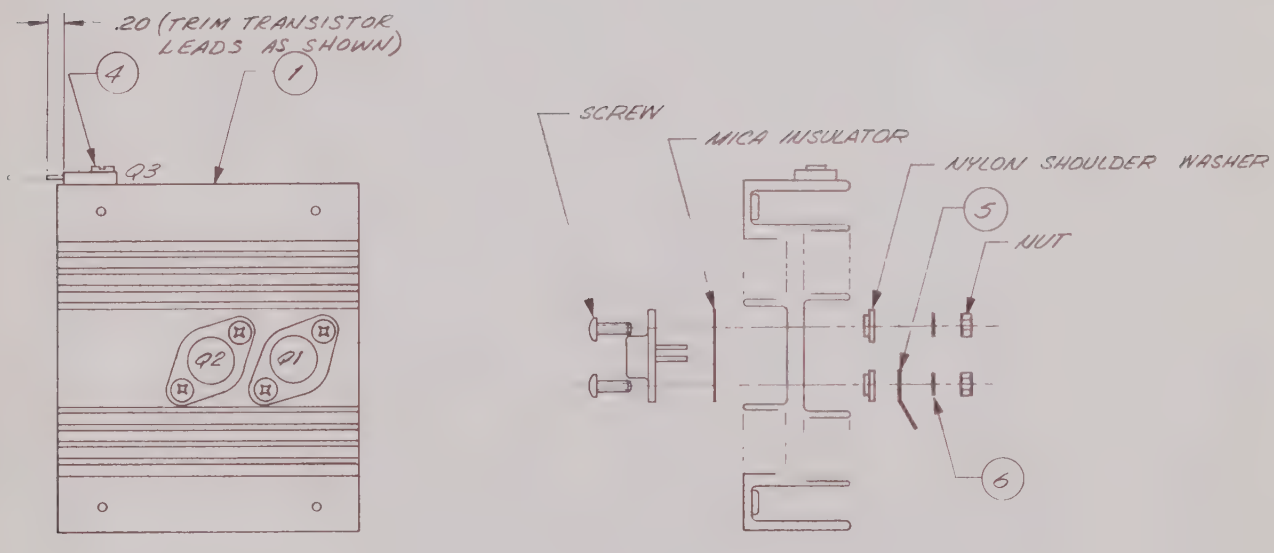
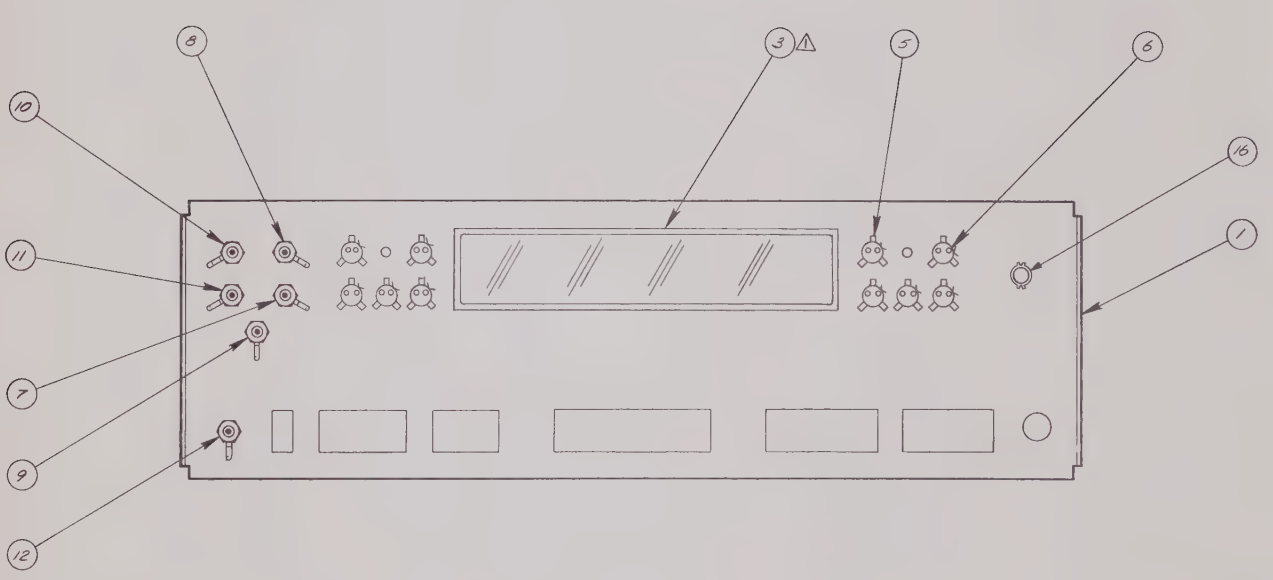


Figure 6-10. Heatsink–Power Transistor Subassembly.



NOTE:
⚠ BOND ITEM 3 TO ITEM 1 WITH APPROVED ADHESIVE PER APPROVED METHOD

Figure 6-11. Front Panel Assembly.

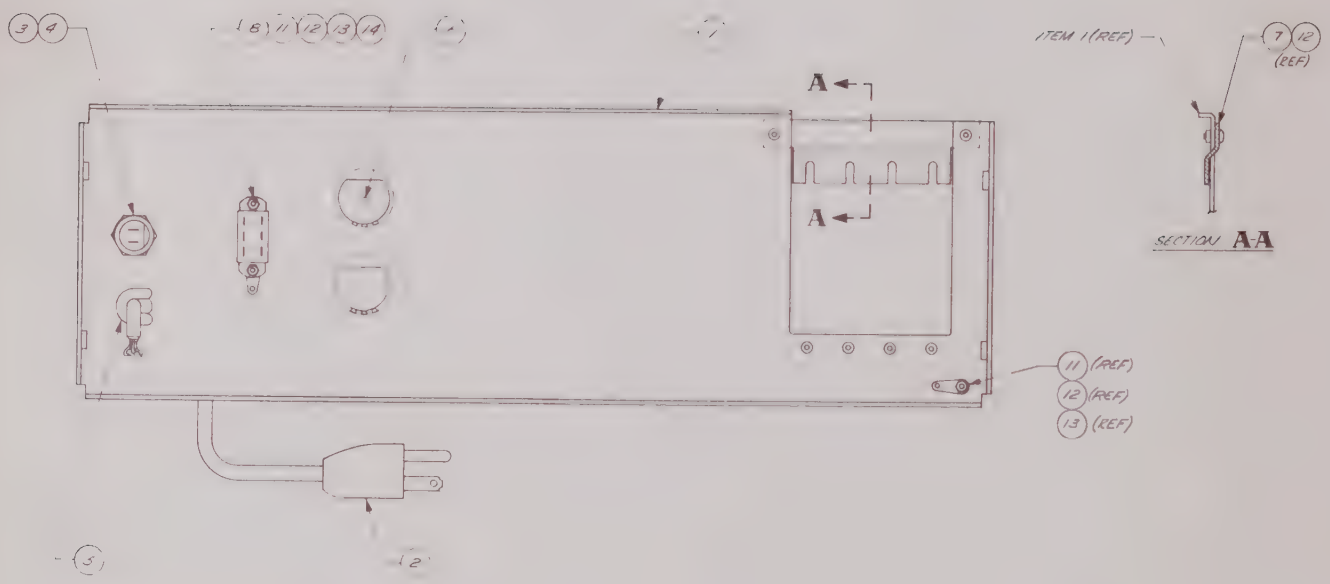
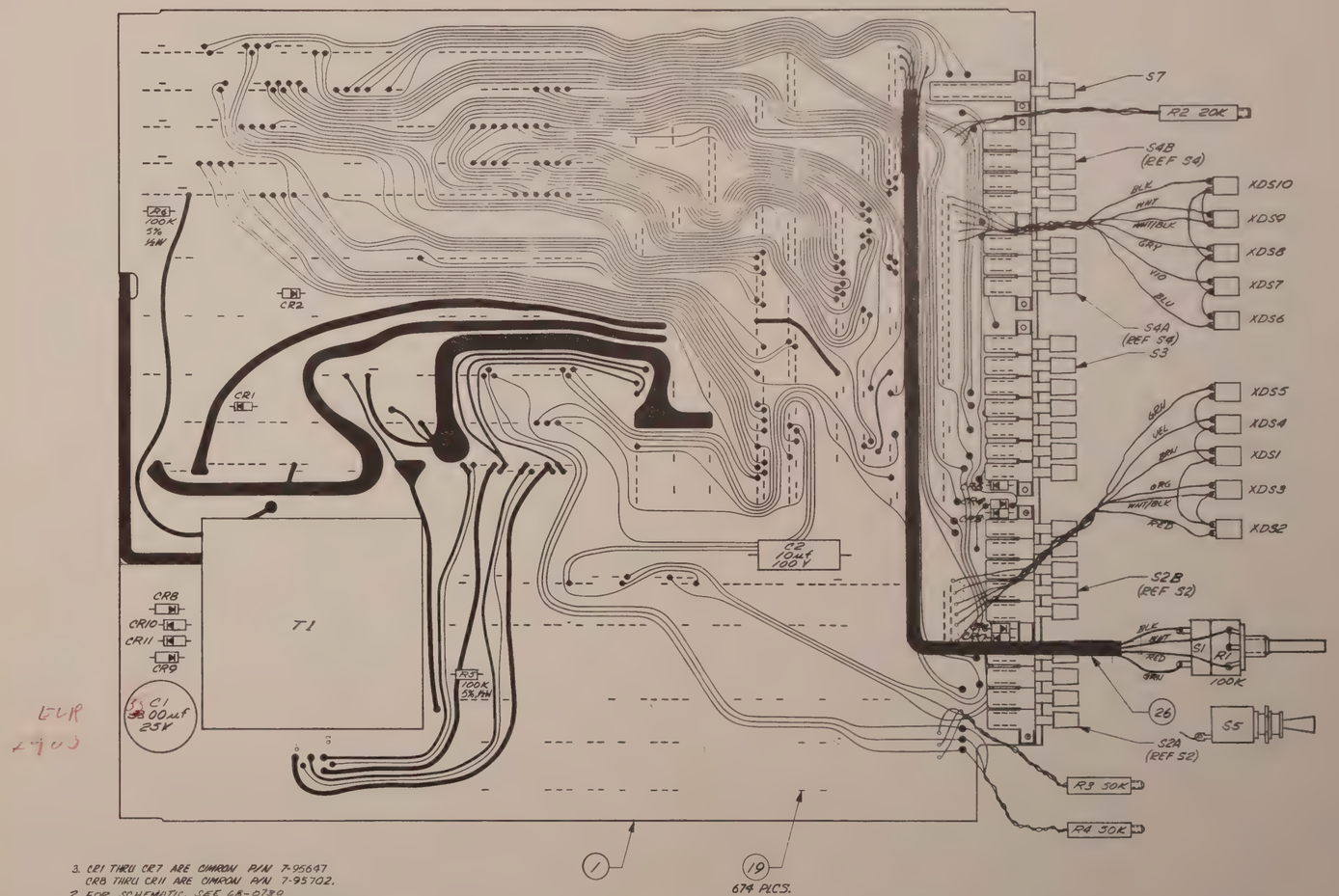


Figure 6-12. Rear Panel Assembly.

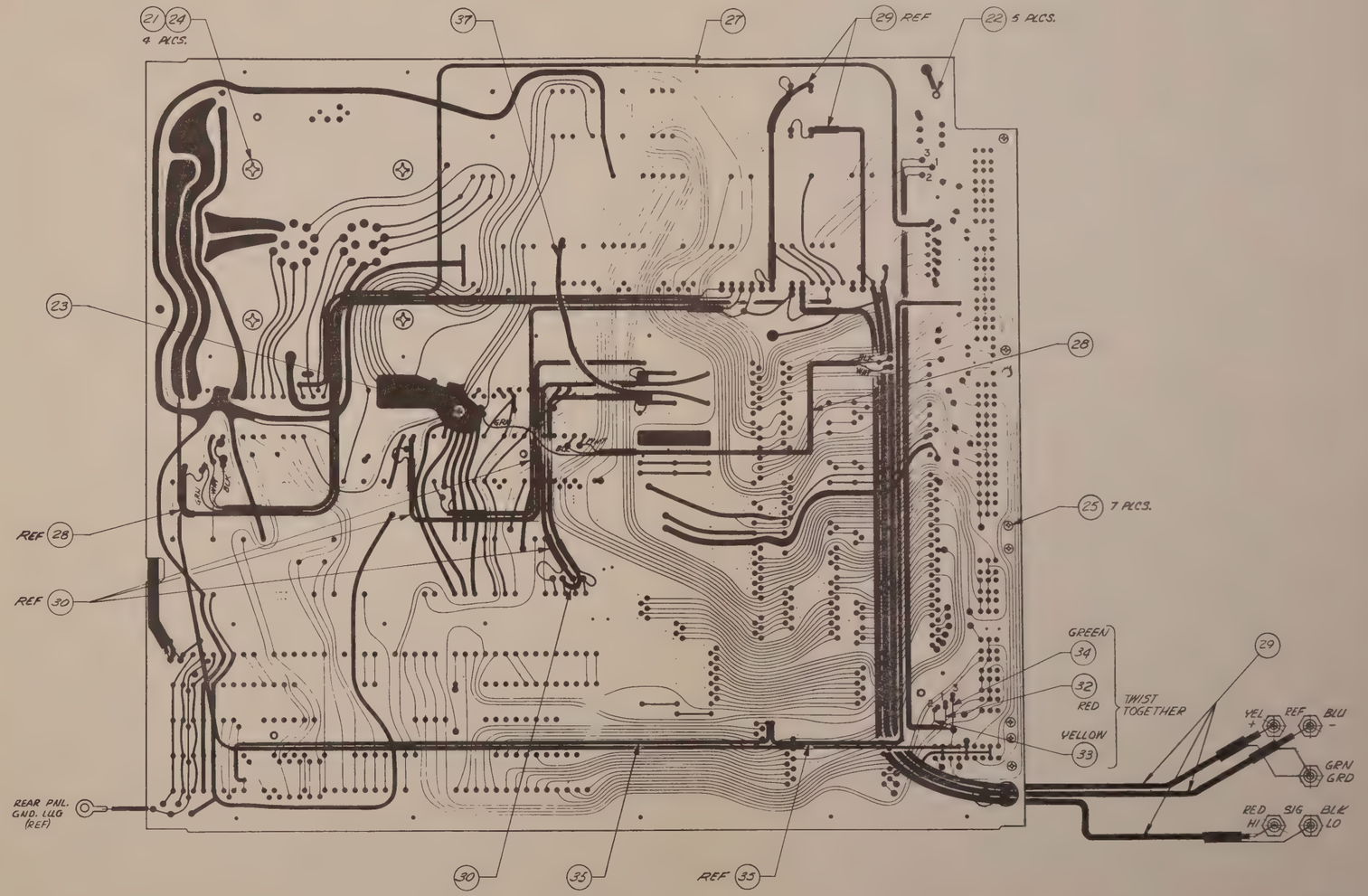


3. CR1 THRU CR7 ARE CIMRON P/N 7-95647
   CR8 THRU CR11 ARE CIMRON P/N 7-95702.
2. FOR SCHEMATIC, SEE 6A-0730.
1. PARTIAL REFERENCE DESIGNATIONS SHOWN FOR COMPLETE DESIGNATIONS PREFIX WITH A1

NOTES: UNLESS OTHERWISE SPECIFIED

ELR 1905

Master Board Assembly (Sheet 1 of 3).



Master Board Assembly (Sheet 2 of 3).

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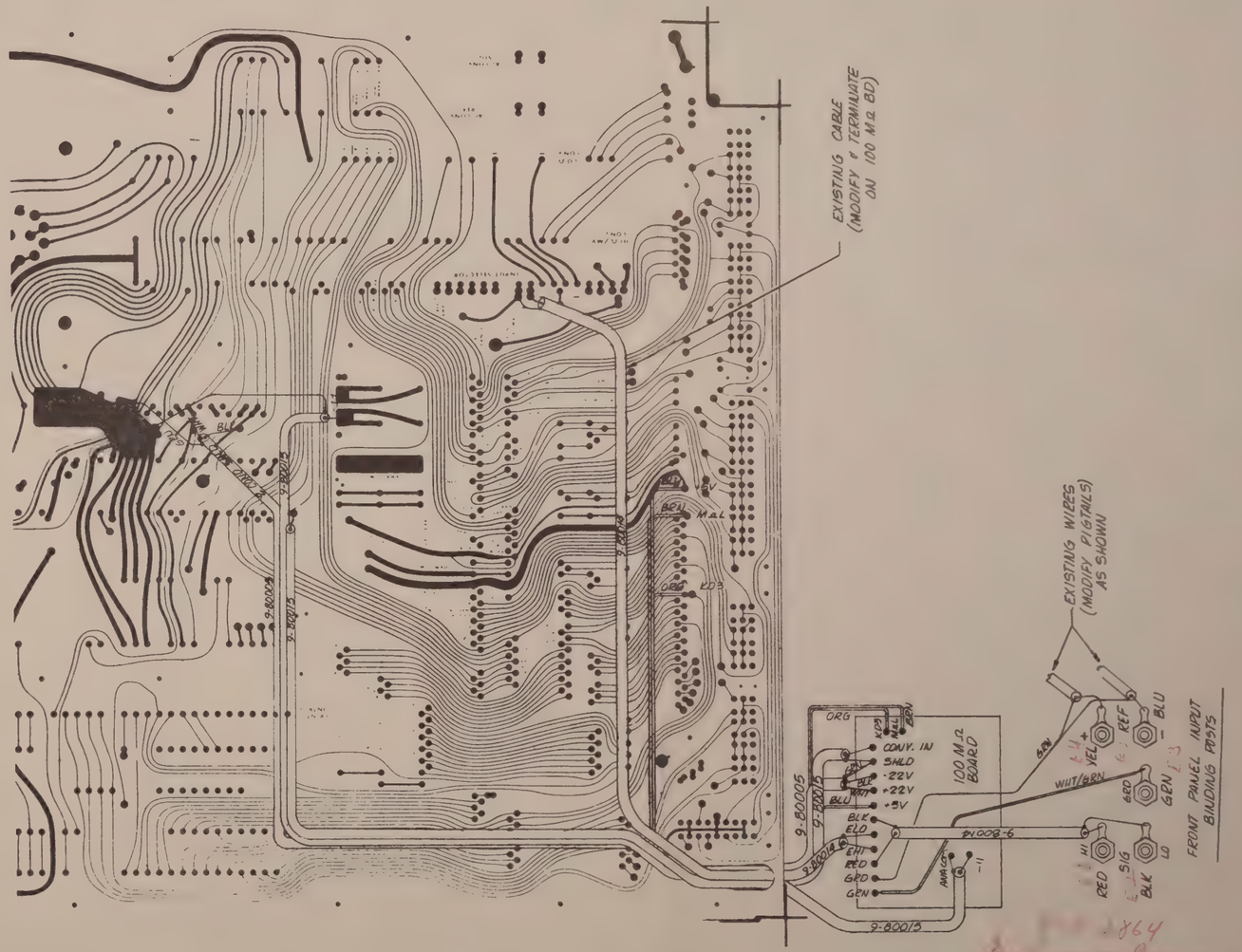
ORIGINAL

ECP-864



Master Board Assembly (Sheet 3 of 3).

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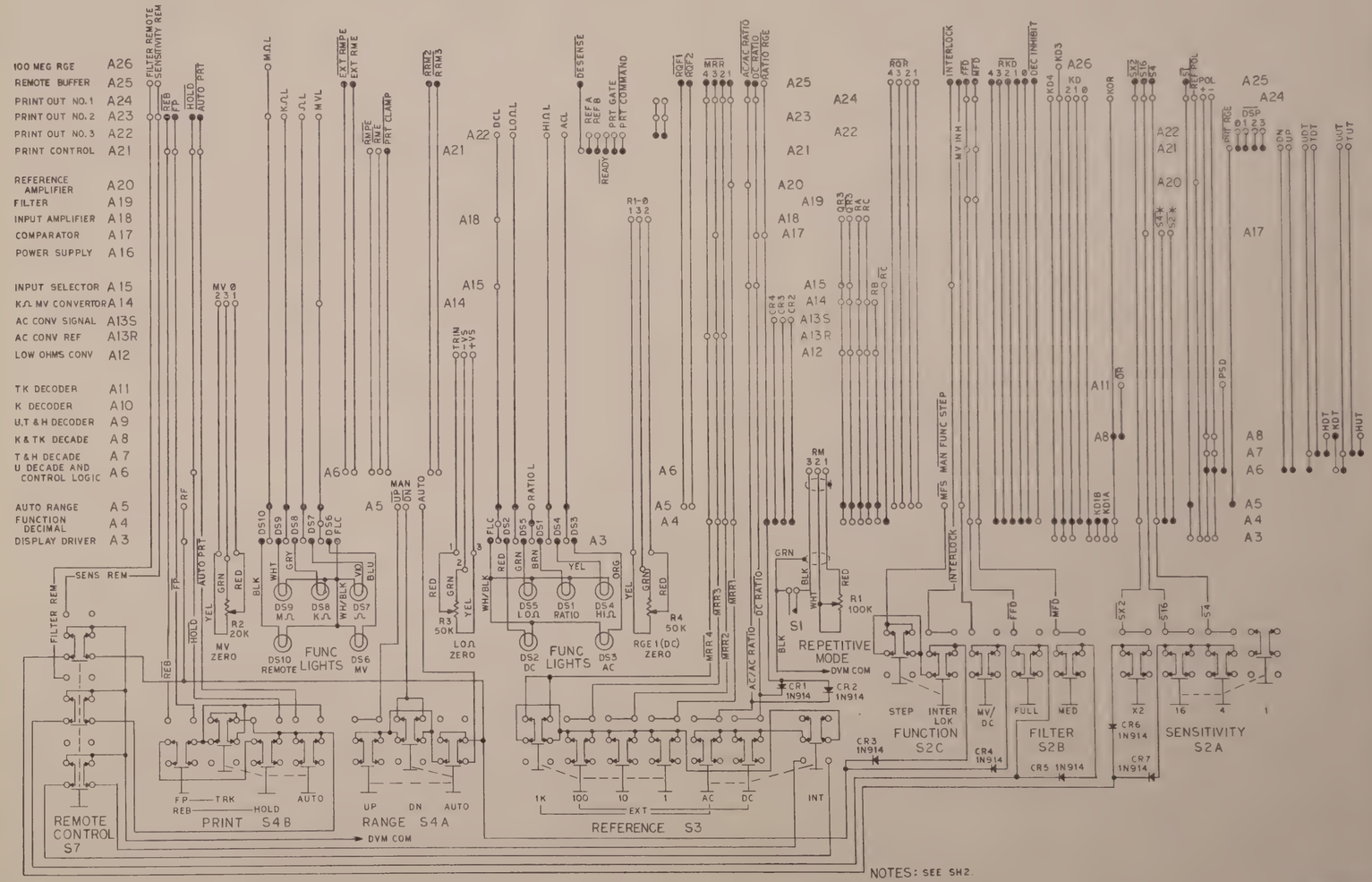

Master Schematic (Sheet 1 of 2).

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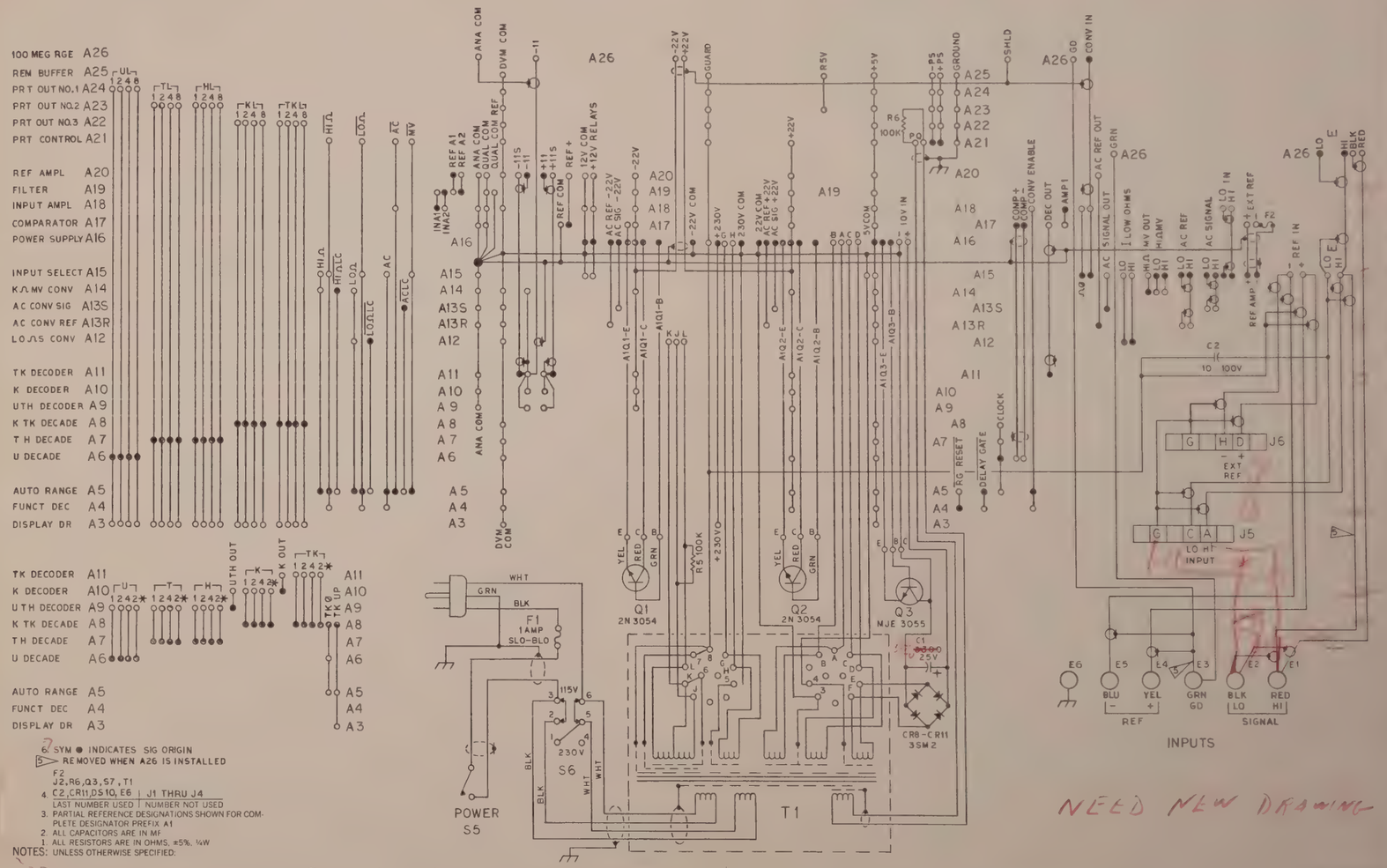
ORIGINAL



NEED NEW DRAWING

#1 WHEN 100 MΩ OPTION IS USED IN CONJUNCTION WITH REAR INPUT CABLE, THE ROUTING MUST CHANGE AS FOLLOWS:
REMOVE: J5A TO A15-HI & J5C TO A15-LO.
ADD: J5A TO FRONT INPUT E1 SIG HI & J5C TO FRONT INPUT E2 SIG LO
* ECR 2863

Master Schematic (Sheet 2 of 2).

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ORIGINAL

SECTION VII

RECOMMENDED SPARE PARTS

Table 7-1 is a recommended list of spare parts for maintaining a specific number of instruments for one year in an isolated area.

Table 7-1. Recommended Spare Parts.

ASSEMBLY OR PART NAME	PART NUMBER	QUANTITY REQUIRED		
		1 INSTRUMENT	2 INSTRUMENTS	3 INSTRUMENTS
Input Selector	68-6035	1	3	5
AC Signal Converter	57-6000	1	3	5
AC Reference Converter	57-6000	1	3	5
Low Ohms Converter	58-6014	1	3	5
HIΩ-MV Converter	58-6015	1	3	5
100 MEG Range	68-6058	1	3	5
Filter and Input Amplifier*	68-5009	1	3	5
Comparator, One Thousand, and Ten Thousands Decoder**	68-5008	1	3	5
Reference Amplifier	68-6040	1	3	5
Units Decade and Control Logic	68-6046	1	3	5
Tens and One Hundreds Decade	67-6087	1	3	5
One Thousand and Ten Thousands Decade	67-6088	1	3	5
Units, Tens, and One Hundred Decoder	67-6089	1	3	5
Autorange	68-6034	1	3	5
Function Decimal	68-6033	1	3	5
Display	68-6032	1	3	5
Print Control	68-6041	1	3	5
DTL Print Output No. 1	68-6051	1	3	5
DTL Print Output No. 2	68-6052	1	3	5
DTL Print Output No. 3	68-6053	1	3	5
Voltage State Positive Ref. Print Output No. 1	68-6059	1	3	5
Voltage State Positive Ref. Print Output No. 2	68-6060	1	3	5
Voltage State Positive Ref. Print Output No. 3	68-6061	1	3	5
Voltage State Negative Ref. Print Output No. 1	68-6055	1	3	5
Voltage State Negative Ref. Print Output No. 2	68-6056	1	3	5

Table 7-1. Recommended Spare Parts (Cont'd).

ASSEMBLY OR PART NAME	PART NUMBER	QUANTITY REQUIRED		
		1 INSTRUMENT	2 INSTRUMENTS	3 INSTRUMENTS
Voltage State Negative Ref. Print Output No. 3	68-6057	1	3	5
BCD Contact Closure Print Output No. 1	68-6048	1	3	5
BCD Contact Closure Print Output No. 2	68-6049	1	3	5
BCD Contact Closure Print Output No. 3	68-6050	1	3	5
Ten-Line Print Output No. 1	68-6042	1	3	5
Ten-Line Print Output No. 2	68-6043	1	3	5
Ten-Line Print Output No. 3	68-6044	1	3	5
Remote Buffer	68-6045	1	3	5
Remote	68-6054	1	3	5
Power Supply	68-6036	1	3	5
Signal Input Cable	68-5011-1	1	2	3
Reference Input Cable	68-5012-1	1	2	3
Master Circuit Board Subassembly	68-6030	1	3	5
Heatsink Power Transistor Subassembly	68-5010	1	3	5
Extraction Tool	70-9500-1	1	3	5
Fuse 1 AMP, SLO-BLO	4-08017	5	5	10
Fuse Resistor 50 mA	4-09013	5	5	10
Fuse Resistor, 100Ω, 1%	4-09013	5	5	10
Fuse Resistor, 2 KΩ, 5%	4-09014	5	5	10
Logic Tester	67-6104	1	1	2
Extender Board, 9-inch	66-9500-1	1	1	2

*Consists of Filter Amplifier Subassembly PN 68-6039 and Input Amplifier Subassembly PN 68-6038.

**Consists of Comparator Subassembly PN 68-6037, 1K Decoder Subassembly PN 67-6090 and 10K Decoder Subassembly PN 67-6091.

IMPORTANT

Include the instrument model number and serial number in any correspondence regarding this instrument. The serial number must match the instrument serial number if parts are to be ordered from the manual. Your help in this will enable us to answer your inquiries and fill your order with the least possible delay.

WARRANTY

All CIMRON instruments are fully warranted to be free from defects in material and workmanship for a period of one year as per CIMRON's standard terms and conditions of sale. This warranty does not, however, cover tubes, transistors, choppers, fuses and/or batteries. Mechanical stepping switches are guaranteed for ninety days provided they have been lubricated in accordance with manufacturers instructions.

Should replacement parts be required, whether at no charge under warranty or at established net prices, notify us promptly, including sufficient details to identify the required parts. We will ship them (SHIPPING CHARGES COLLECT) as soon as possible, usually within twenty-four hours.

In the event factory service or assistance is required for this instrument:

1. Give CIMRON's Customer Service Department prompt notice in writing of the nature of any suspected defects.

2. Upon receipt of written authorization and shipping instructions from CIMRON, return the instrument (TRANSPORTATION CHARGES PREPAID) to CIMRON's main plant located at 1152 Morena Boulevard, San Diego, California 92110. The instrument will be returned to the customer TRANSPORTATION CHARGES COLLECT.

3. CIMRON will acknowledge receipt of the instrument and indicate warranty status. No charge will be made for repairs covered by terms of this warranty OTHER THAN TRANSPORTATION CHARGES.

4. In the event repairs are "out of warranty", CIMRON will provide the customer with a quotation which will require the customer's approval before the work can be accomplished. Return of the instrument to the customer shall be with TRANSPORTATION CHARGES COLLECT.

CIMRON reserves the right to adjust the prices and make design modifications without notice.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested as soon as it is received. If it does not operate or is damaged, a claim should be filed with the carrier. A copy of the claim should be sent to CIMRON. Upon receipt of the claim we will advise you of the disposition to be made of the instrument and arrangements will be made for repair or replacement. Do not return an instrument to CIMRON without prior approval.

The above statements and warranty constitute a part of our Standard Terms and Conditions of Sale as published in our order acknowledgement which is CIMRON's Warranty in its entirety.

LEAR SIEGLER, INC.

CIMRON DIVISION,
1152 MORENA BOULEVARD,
SAN DIEGO, CALIFORNIA 92110

ELECTRONICS FOR MEASUREMENT – CONTROL – AUTOMATION